Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

AUGUST, 1950

TABLE OF CONTENTS, Page 33

TECHNOLOGY DEPT.

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DETROIT

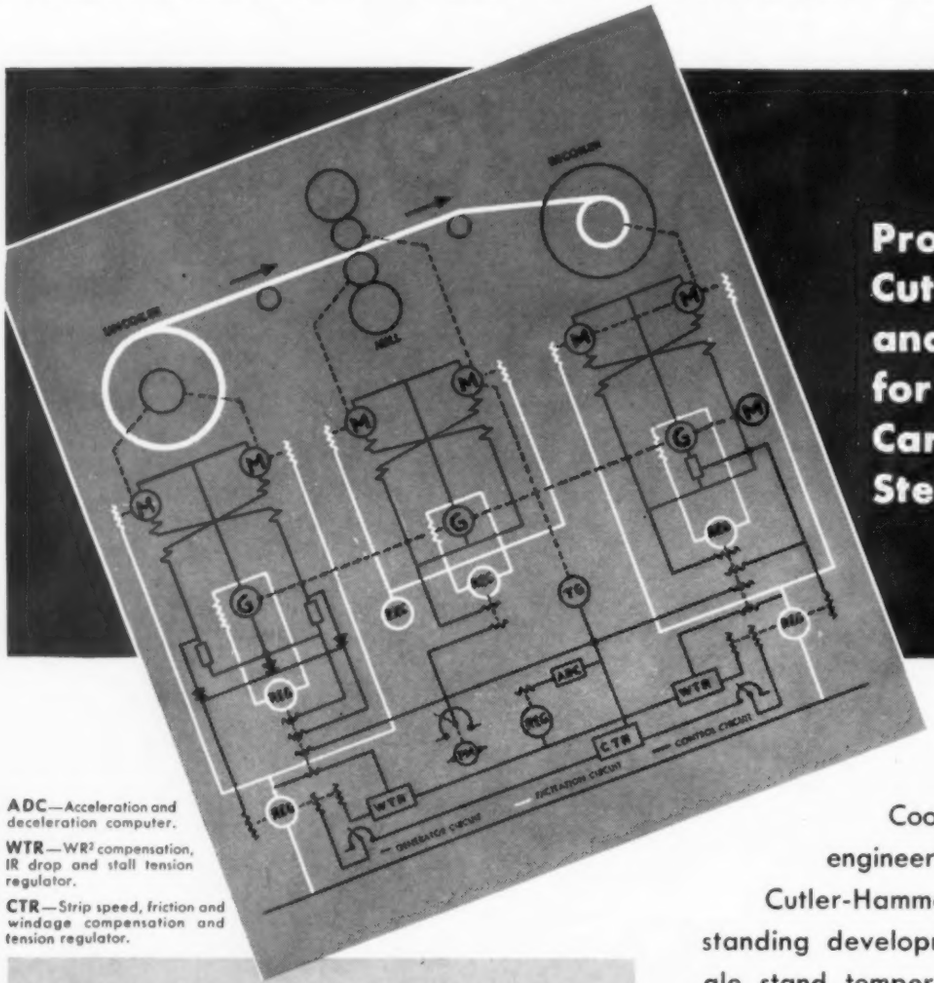
MESTA
MACHINE COMPANY
Pittsburgh Pa.

Modern FOUR-HIGH REVERSING PLATE MILLS

Designed and Built By **MESTA**

Kodachrome by E. D. Mesta

Modern high speed temper mill drive maintains accurate tension at 2500 F.P.M.



ADC—Acceleration and deceleration computer.

WTR—WR^2 compensation, IR drop and stall tension regulator.

CTR—Strip speed, friction and windage compensation and tension regulator.

Produced by Cutler-Hammer and Elliott Engineers for the Irvin Works, Carnegie-Illinois Steel Corporation

Features of the New Temper Pass Mill Drive

All operations are performed from an operator's cabinet at each end of the mill. Threading the strip through the single stand mill is accomplished in minimum time. Strip tension between mill and reels is then regulated to any desired value by means of the VSA current regulating exciters of each reel. By proper adjustment of the compensation for IR drop, friction, windage, and strip speed, the tension may either be held constant or tapered as required to provide a uniform quality of the processed strip. Any change in reel motor current and thus the tension, is translated to the VSA regulators which immediately modify the reel motor fields in such a way as to re-establish the tension. Sudden transient requirements of a wider current modification are also translated to the VSA voltage regulators of the reel generators which immediately respond to assist in establishing the desired current. The required change in current and torque when accelerating and decelerating is measured by a WR^2 compensating device which responds to actual rate of change in speed of the mill and thus insures the proper compensation with any rate of acceleration.

Cooperative efforts between the engineers of the Elliott Company and Cutler-Hammer have resulted in an outstanding development . . . the high-speed, single stand temper pass mill drive. The speed of the mill has been stepped up from 500 feet per minute to 2500 feet per minute with provisions for 3750 feet per minute in the future. Other operating features of this drive are described in the box at the left. In the greater production of high quality steel from this mill, you will find a hint why you should consult Cutler-Hammer Mill Control Engineering experience. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

One of a SERIES of advertisements featuring basic heavy duty power circuits . . . and showing Cutler-Hammer's broad design and application experience which has made it the preferred control for the steel industry.

CUTLER-HAMMER
MOTOR CONTROL
C-H

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 27, No. 8

● **Production**—Increased production of 100% in the smaller pipe sizes due to maximum speed increase from 500 f.p.m. to 1,000 f.p.m.

Cutting—New, continuously running rotary type flying Hot Saw entirely eliminates high maintenance of conventional reciprocating type saws. Cuts to closer tolerances. Operates at twice the speed of hot saws now in use.

Efficiency—Furnace efficiency has been greatly improved. By utilizing wider skelp than in older installations, you have much lower B.T.U. per ton of skelp heated.

Quality—Improved weld by greatly increased reductions in this 12-stand Forming and Welding Mill.

Other Features—1. New Rotary type kickout for high pipe speeds. 2. Hot straightening in line of production. 3. Screw type cooling bed.

Aetna-Standard builds more Continuous Butt Weld Pipe Mills and Seamless Tube Mills than all other companies combined. Ask us about the 12-stand butt weld mill, the newest advance in pipe making.

THE AETNA-STANDARD ENGINEERING COMPANY

YOUNGSTOWN, OHIO

ASSOCIATED COMPANIES

AETNA-STANDARD ENGINEERING CO., LTD., TORONTO, ONTARIO, CANADA
HEAD, WRIGHTSON & COMPANY, LTD., THORNABY-ON-TEES, ENGLAND
SOCIETE DE CONSTRUCTIONS DE MONTBARD, 6 RUE DARU, PARIS (8e) FRANCE

CONTINUOUS BUTT WELD PIPE AT 1,000 FT. PER MINUTE

AETNA-STANDARD'S NEW **12-STAND MILL**
REVOLUTIONIZES.. **PIPE MAKING**

5 REASONS WHY YOU CAN DEPEND ON *National Rolls*

METALLURGICAL SKILL

National's metallurgical staff knows the right ingredients in the right amounts to meet individual requirements for hardness, wear-resistance and composition.

QUALITY CONTROL

Every step of production from raw material analysis to inspection of the finished roll is closely supervised by National's trained personnel.

BUILT-IN STRENGTH

Sound casting assures rolls of proper strength and hardness for long tonnage life.

PRECISION FINISHING

The most modern machine tool equipment finishes rolls to your exact specifications.

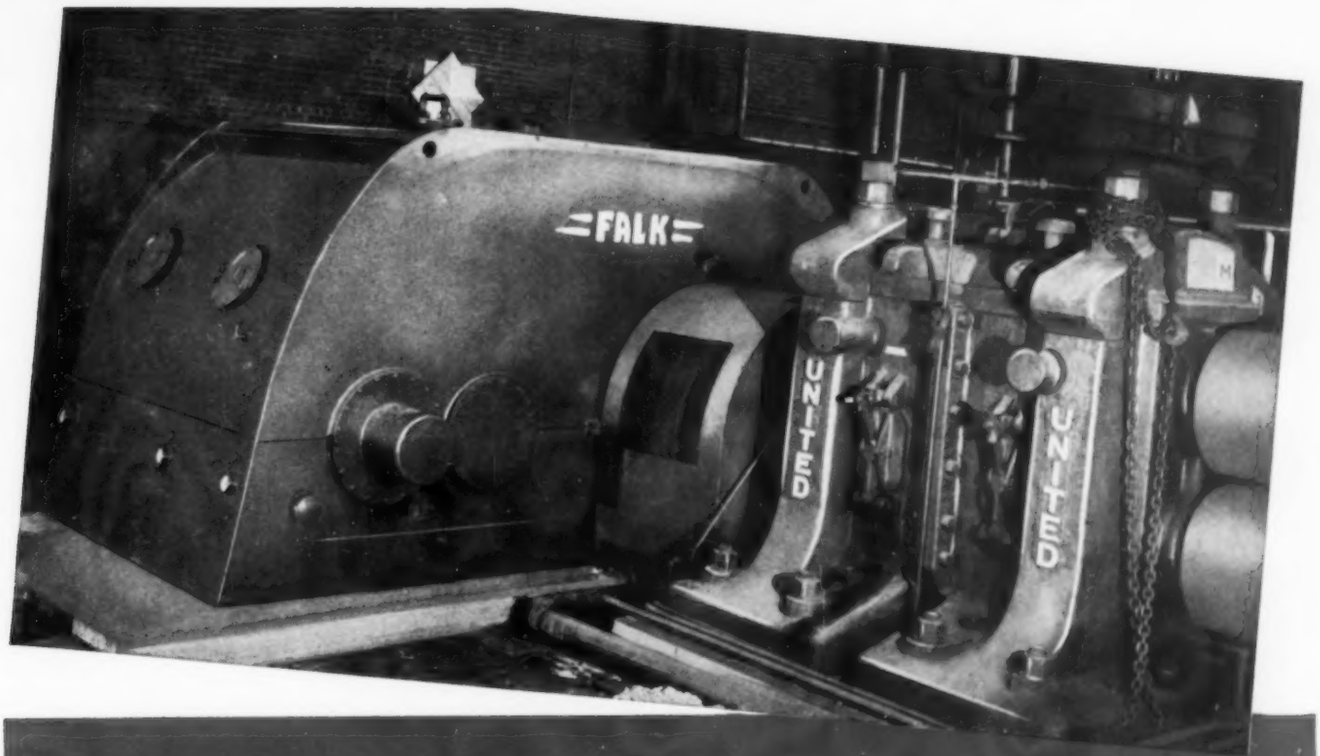
LONG TIME ROLL MANUFACTURERS

For more than forty years we have been supplying to leading fabricators all types of rolls for metal rolling and forming.

THE NATIONAL ROLL & FOUNDRY CO.

AVONMORE, PENNSYLVANIA

SPECIALISTS IN IRON & ALLOY IRON ROLLS AND CASTINGS



SAVINGS YOU CAN GET YOUR GEAR TEETH INTO

Lower maintenance costs, fewer replacements, when you use TEXACO MEROPA LUBRICANTS

ONLY lubricants made for the job can take the extreme pressures generated in enclosed reduction gears and pinion stands, giving gears and bearings full protection. *Texaco Meropa Lubricants* are like that—especially designed to prevent metal-to-metal "gnashing" of gear teeth no matter how great the "squeeze."

This means smoother operation and less wear, longer gear life and lower maintenance costs. And the extra long life of *Texaco Meropa Lubricants* is an added saving.

You will also find *Texaco Meropa Lubricants* notably resistant to oxidation and thickening. They do not foam; do not separate in service, storage or centrifuging; and they protect bearings against corrosion.

Another place to reduce maintenance costs is your oil film roll necks. Use *Texaco Regal Oils* heavy-duty turbine-grade oils with positive resistance to oxidation, emulsification and sludging. They will keep your circulating systems clean, bearings fully protected.

The savings a Texaco Lubrication Engineer can help you achieve throughout your mill are well worth while. Just call the nearest of the more than 2,000 Texaco Wholesale Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

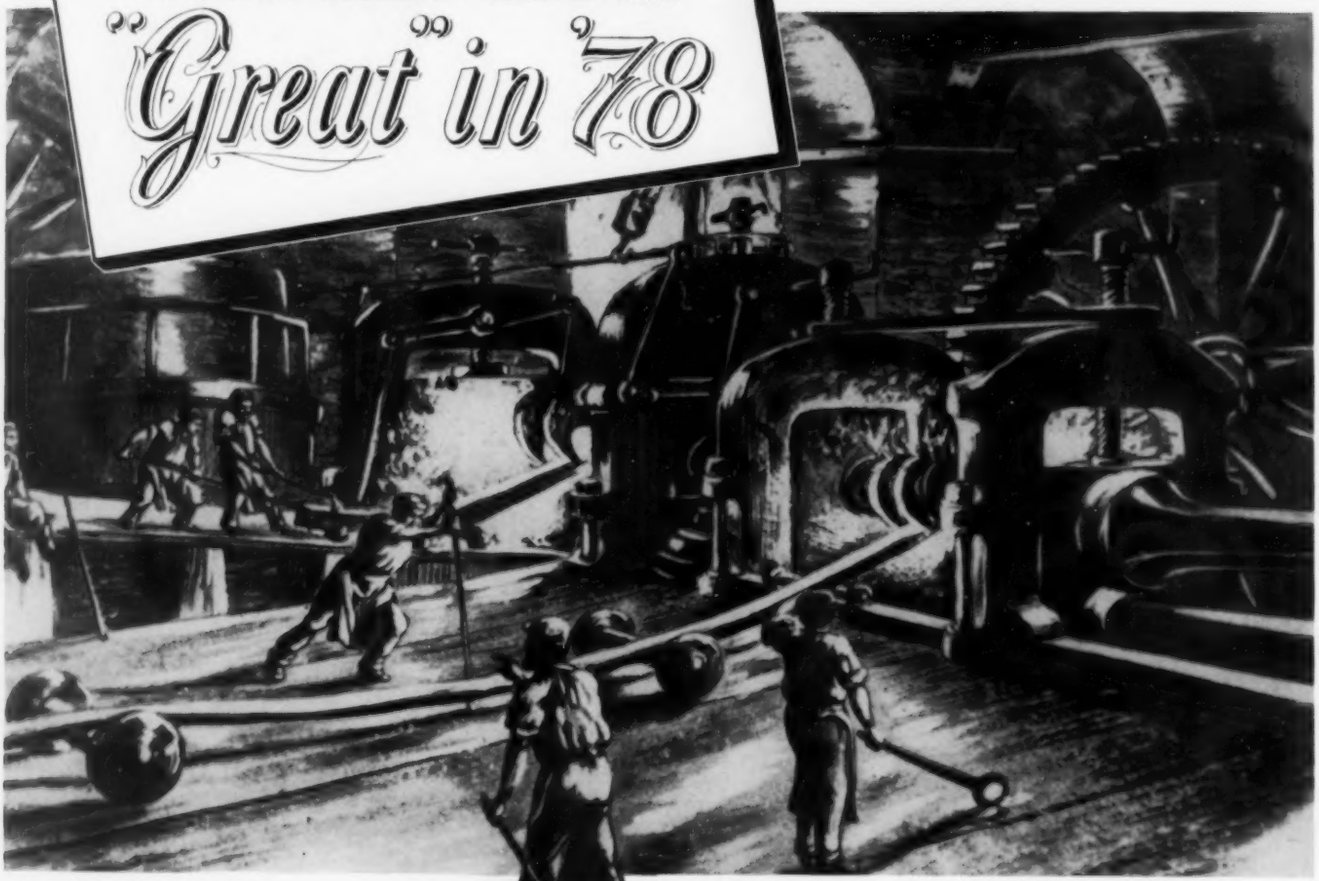
TEXACO

TEXACO Meropa Lubricants

FOR STEEL MILL GEAR DRIVES

THE STEEL INDUSTRY HAILED THIS

"Great" in '78



Photograph courtesy The Bettmann Archive

Don't miss the Industry's latest developments

AT THE 1950

Iron and Steel Exposition

CLEVELAND

SEPTEMBER 26, 27, 28, 29

Many time, effort and money saving methods have been developed for every phase of iron and steel production, since the days of this antiquated rolling mill. The latest in cost-cutting equipment, supplies and services will be on display at this year's Big Exposition in Cleveland. Every man in a supervisory capacity in your plant should attend. One good cost-cutting idea will make the trip more than worth while. Time spent will be measured in production dollars saved.

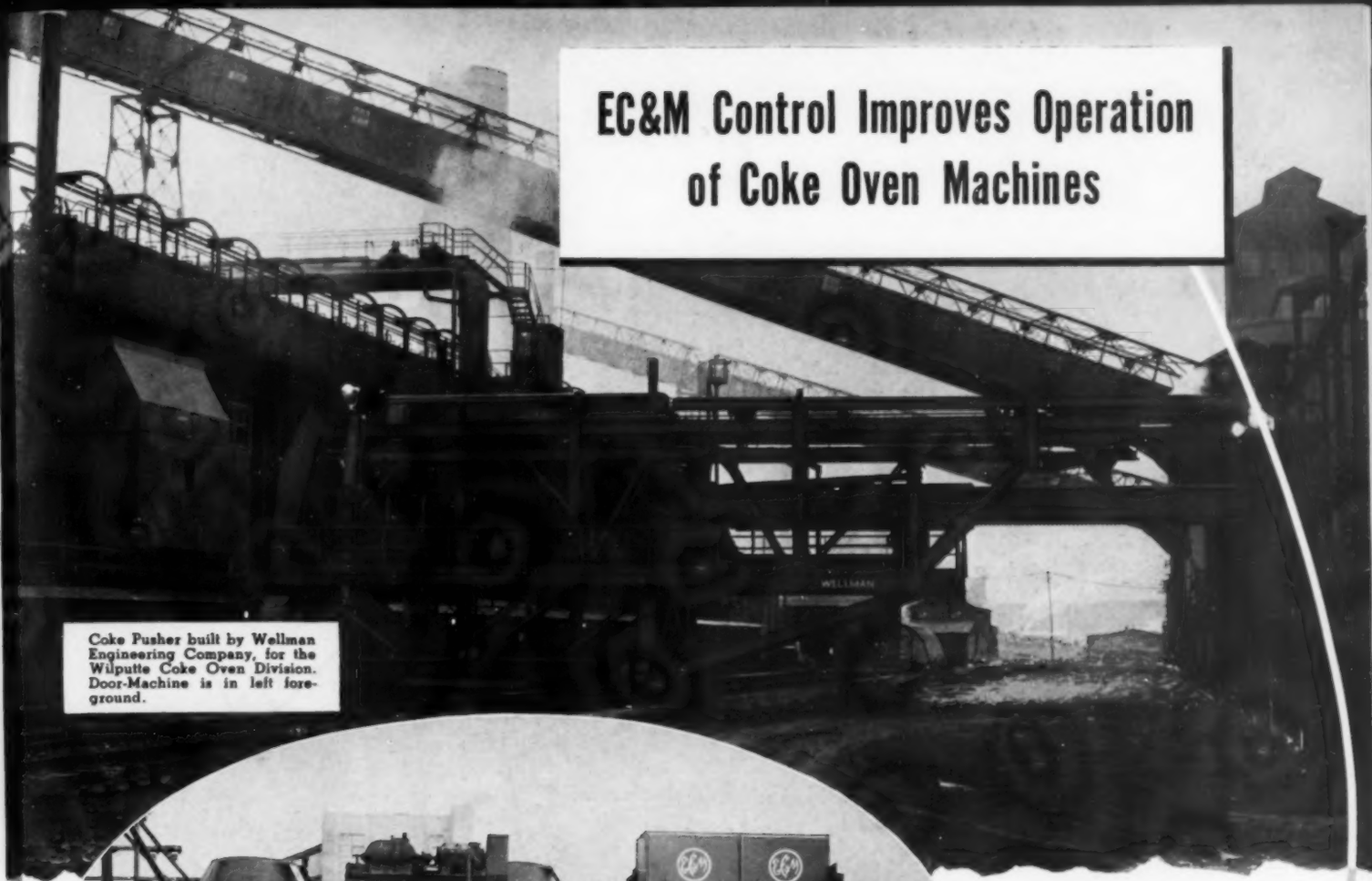
Tickets are FREE! Write today for the quantity you need.

AIS

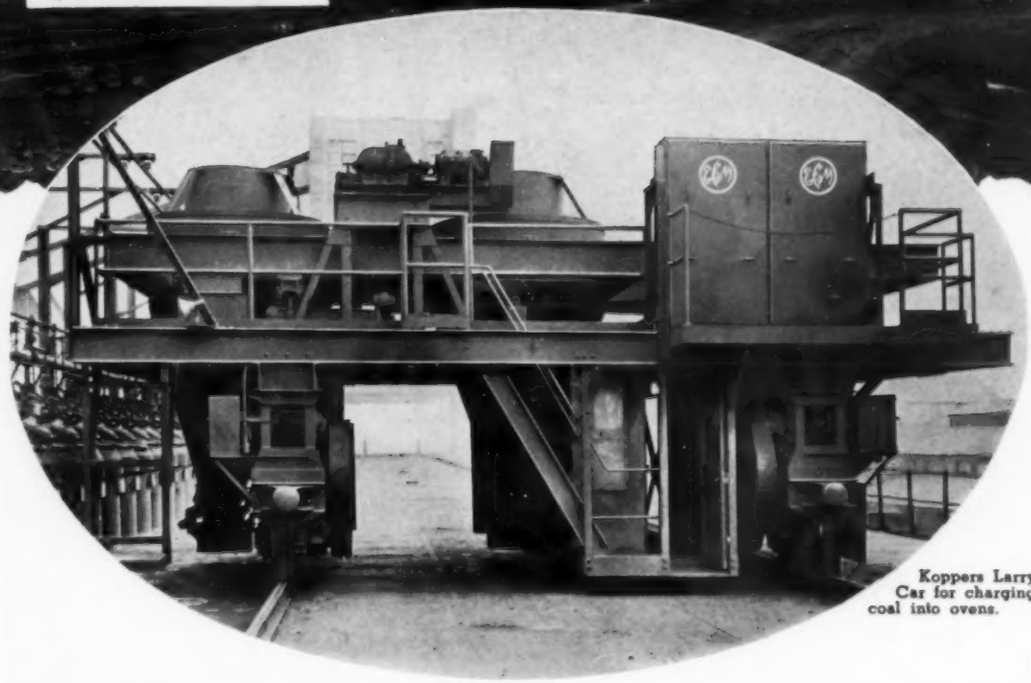
ASSOCIATION of IRON and STEEL ENGINEERS

1010 EMPIRE BUILDING · PITTSBURGH 22, PA.

EC&M Control Improves Operation of Coke Oven Machines

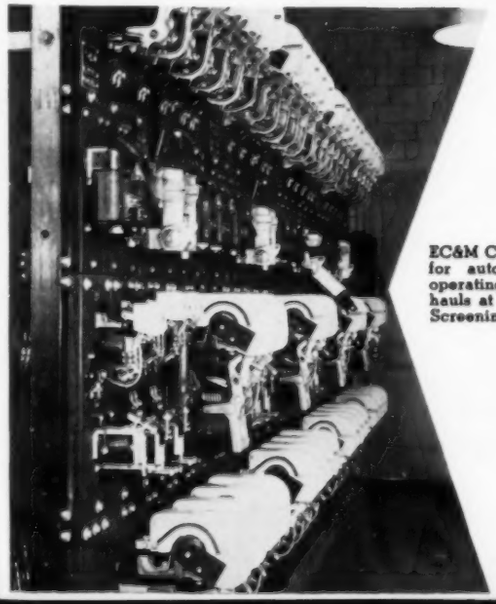


Coke Pusher built by Wellman Engineering Company, for the Wilputte Coke Oven Division. Door-Machine is in left foreground.



Koppers Larry Car for charging coal into ovens.

Here's How



EC&M Controllers for automatically operating four car-hauls at the Coke Screening Station

1. Controllers using EC&M LINE-ARC Magnetic Contactors have long contact-life, due to cool contact operation. And there is no destructive arc-shield burning.
2. These coke machines accelerate quickly and smoothly under the EC&M TIME-CURRENT Method of Acceleration—this is a proven system giving fast, safe performance. There's only one adjustable relay for plugging, too.
3. Equipment of sound basic design applied by accurate engineering results in excellent operation of the machines from the first operation throughout their entire life.

The buyers of the machines, here illustrated, selected EC&M Control. You, too, can benefit when buying new machines or revamping existing installations, by specifying EC&M Control, Brakes and Limit Switches.

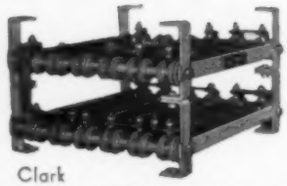
THE ELECTRIC CONTROLLER & MFG. CO.

2698 East 79th Street Cleveland 4, Ohio

CLARK offers ALL CONTROL EQUIPMENT for SAFE, EFFICIENT CRANE OPERATION *from one reliable source!*

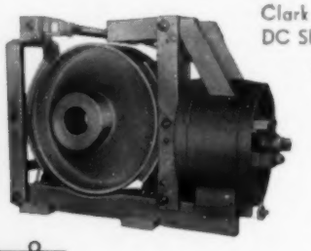
CLARK standard crane control gives dependable performance, safe operation and minimum up-keep. All equipment is "tailored" to the requirements of the particular crane. Brake windings, Resistor ratings, Relays, etc. are all built to the specific needs—thus giving immediate use, smooth performance, and top level production.

Clark Bulletin 101-RD Master Switch for Mill and Crane Control

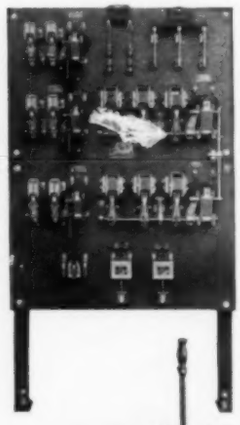


Clark Bulletin 110 Edgewound Resistor

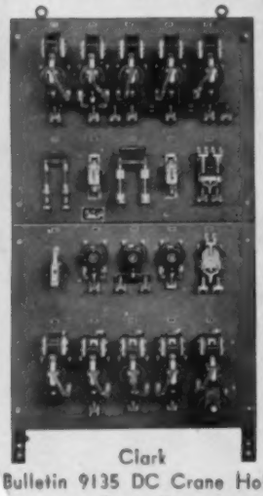
Clark Bulletin 102-CHL Crane Hook Limit Switch



Clark Bulletin 106 DC Shoe Brake ←



Clark Bulletin 9230 AC Magnetic Crane Controller—Reversing →



Clark Bulletin 9135 DC Crane Hoist Controller

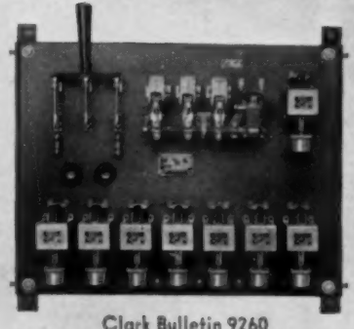
Clark Bulletin 9136 DC Crane Hoist, Bridge and Trolley Controller

Clark Bulletin 9139 DC Floor Operated Crane Controller

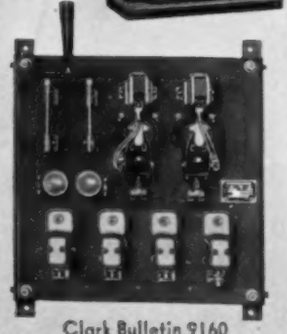
Clark Bulletin 9250 Size No. 2 Reversing AC Manual Face Plate Controller →

Pendant Type Push Button Station for Bulletin 9135 Floor Operated Crane Controller

Pendant Type Push Button Station for Bulletin 9135 Floor Operated Crane Controller



Clark Bulletin 9260 AC Crane Protective Panel



Clark Bulletin 9160 DC Crane Protective Panel

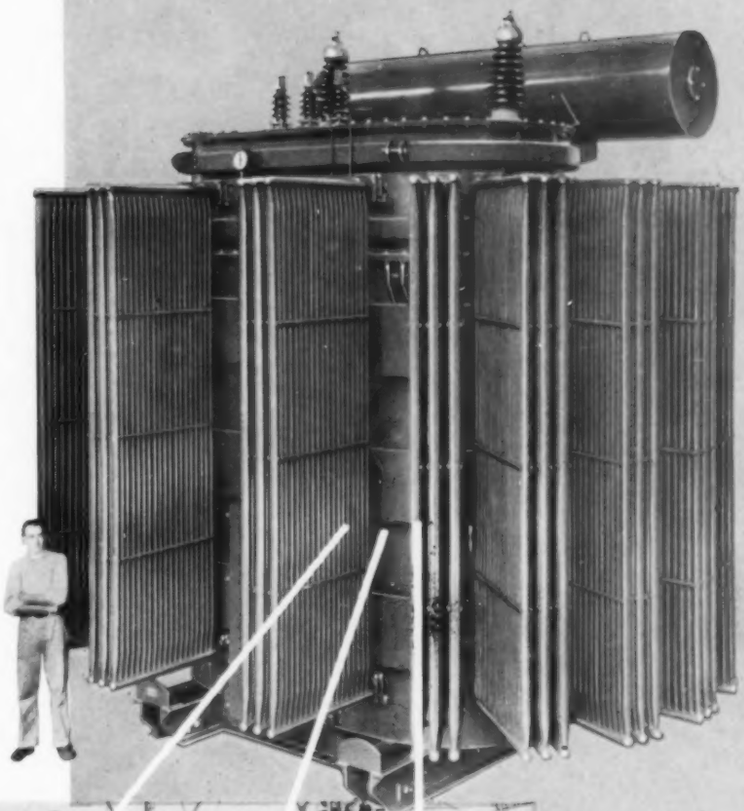
FOR COMPLETE *Crane Control* SPECIFY CLARK

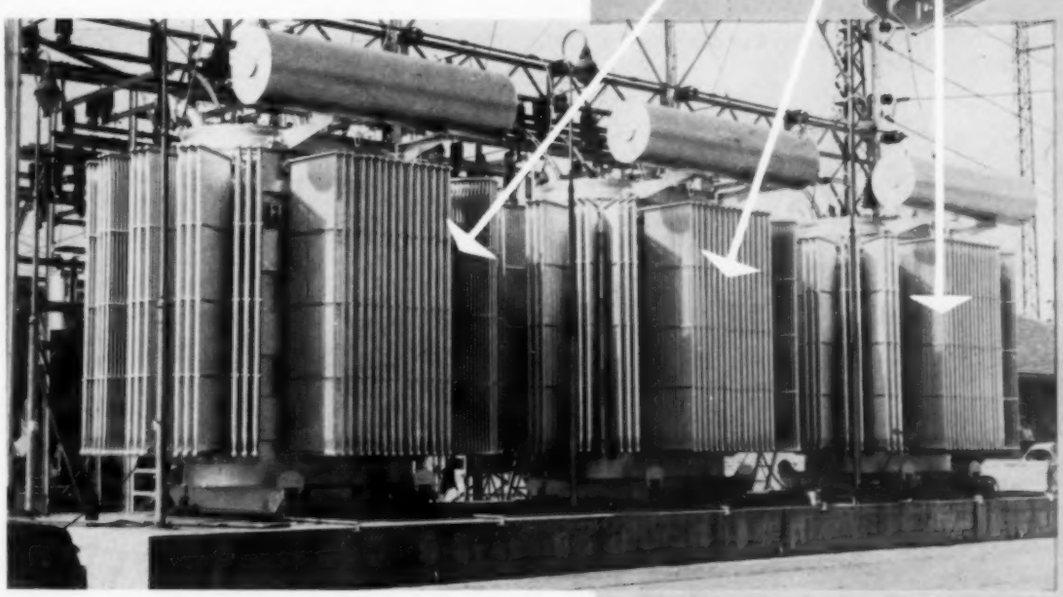
THE CLARK CONTROLLER CO.

EVERYTHING UNDER CONTROL • 1146 EAST 152nd STREET, CLEVELAND 10, OHIO

3 OF A KIND makes 75,000 KVA

Each year more and more Pennsylvania Power Transformers in a greater variety of sizes and voltages are being specified by leading utilities throughout the country. Pennsylvania is now filling orders for transformers with ratings of 35,000, 70,000 and 105,000 Kva. Transformers of all voltage classes up to and including 230 Kv are regularly manufactured in Pennsylvania's completely equipped plant. Pennsylvania is now also manufacturing a full line of Step Voltage Regulators, Unit Substations, and Load Ratio Control Transformers.

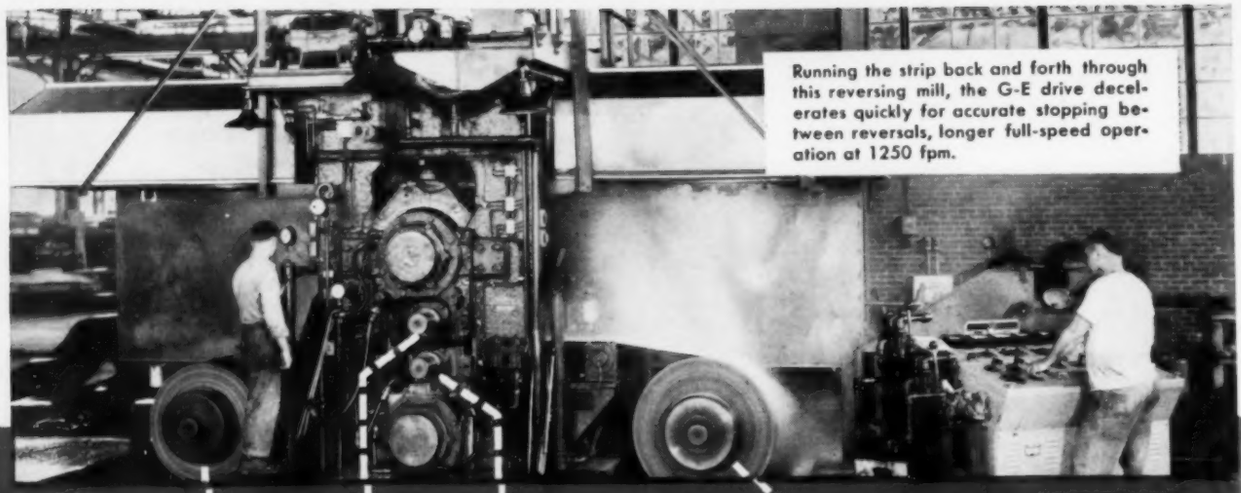




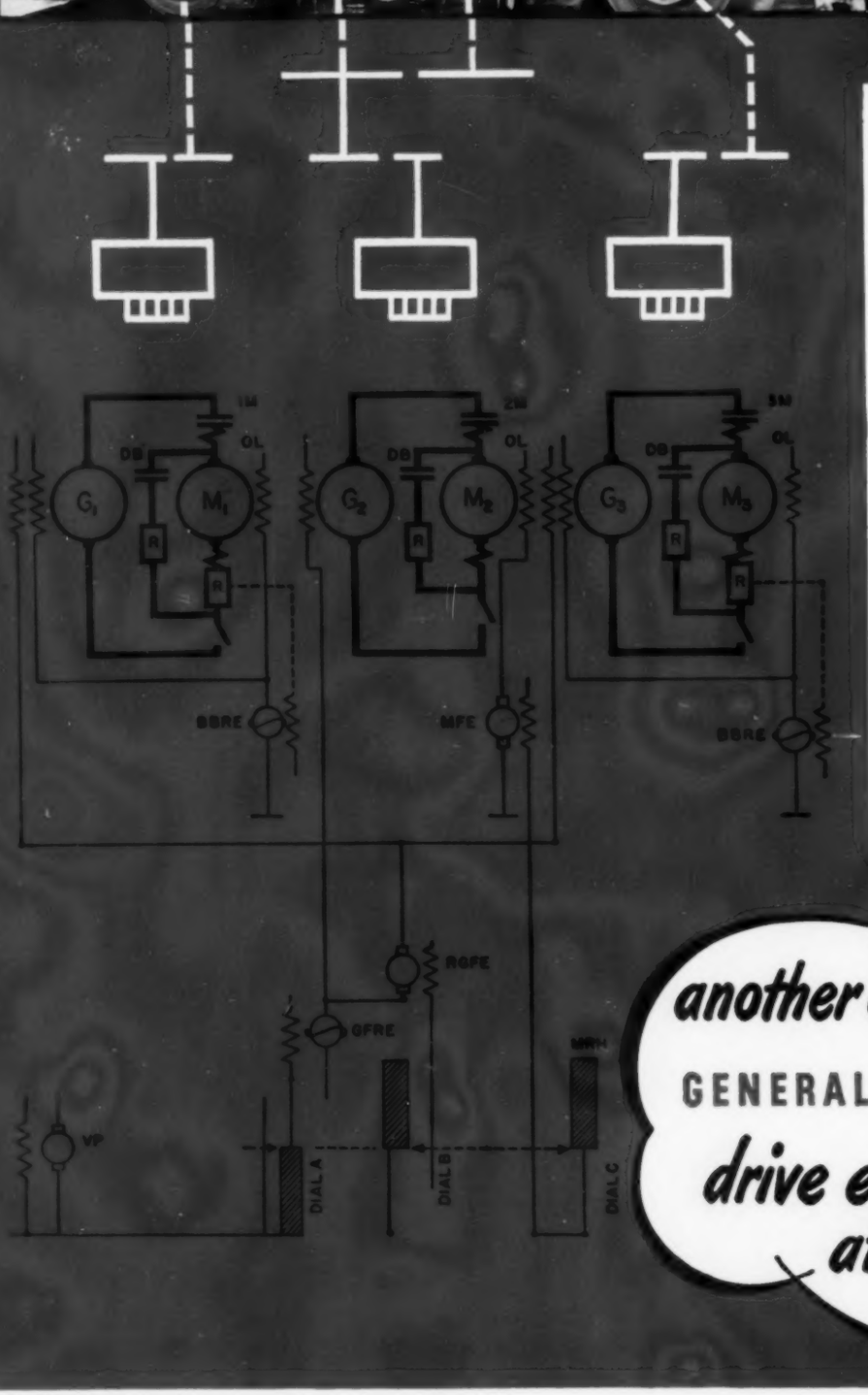
Three single phase Pennsylvania Transformers —each rated 20,000/25,000 Kva, 69 Kv—recently installed in an important sub-station of a Western Utility.

Pennsylvania TRANSFORMERS

Pennsylvania
TRANSFORMER COMPANY
Canonsburg, Penna. · Greater Pittsburgh District



Running the strip back and forth through this reversing mill, the G-E drive decelerates quickly for accurate stopping between reversals, longer full-speed operation at 1250 fpm.



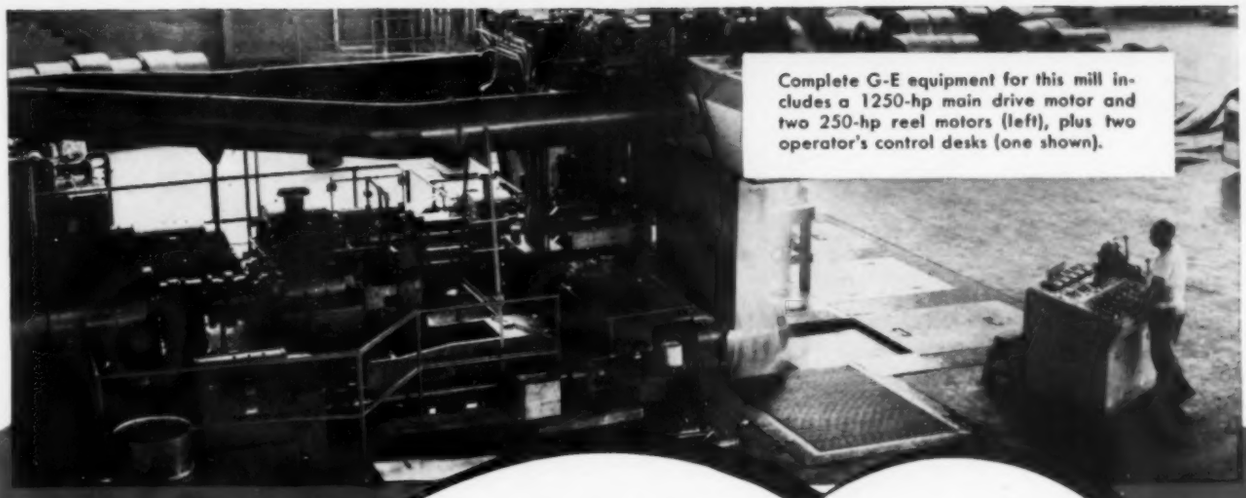
HOW THIS MILL WORKS

Speed of the mill is set by the speed of the main motor (M_2). This speed is controlled by generator (G_2) voltage up to base speed. Voltage is regulated to a value set by the motor operated rheostat (MRH) through an amplidyne exciter (GFRE). Speeds above base speed are obtained through field weakening by adjusting the motor field exciter (MFE) voltage. The reel motors (M_1) and (M_3) stay synchronized with (M_2) at all times by pulling or dragging with substantially constant tension. This is assured by adjusting the voltage of the reel generators (G_1 and G_3) to a value proportional to the strip speed, through a combination of the output of the amplidyne (GFRE) and the reel generator field exciter (RGFE). The armature current of the reel motors (M_1) and (M_3) is controlled by an amplidyne (BBRE) which acts to buck or boost the shunt field.

another example of

GENERAL ELECTRIC

drive engineering at work!



Complete G-E equipment for this mill includes a 1250-hp main drive motor and two 250-hp reel motors (left), plus two operator's control desks (one shown).

G-E drive for 24" reversing cold-strip mill

maintains strip uniformity, simplifies threading and jogging, boosts "on gage" tonnage!

Here's another in a long list of General Electric steel-mill drives engineered for close quality control, ease of operation, and high output. Installed on a 24" 4-high reversing cold-strip mill in Detroit Steel Corporation's Eastern Mill Division, New Haven, Conn., this drive:

Holds uniform tension at all speeds, which provides uniform gage and surface, reduces strip breakage and roll marking.

Operates either unit independently, in either direction, without disturbing the other. This simplifies threading, permits holding stalled tension on one reel while jogging the other into position.

Accelerates and decelerates rapidly at a uniform, reliable rate from any speed, assuring accurate stopping between reversals, longer operation at top speed. Strip gets "on-gage" faster, stays "on-gage" longer!

It's one more example of General Electric's ability to handle *your* steel-mill drive problems successfully. Why not ask a G-E steel-mill specialist to discuss them with your engineers? *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

NEW JERSEY CHEMICAL PLANT saves in installation cost and obtains protection against atmosphere containing corrosive acids and chlorine, with Okolite-Okoprene Self-Supporting Cable. Illustration shows a typical 90° turn of the new aerial cable installed on existing structures above conventional type feeder supported by cross arms. Longest transmission line is 2000 ft. in this 4000 ft. Okonite-Okoprene primary distribution system.

ALABAMA GLASS WORKS installs 4000 ft. of Okolite-Okoprene Self-Supporting cable at new plant. Neat, modern appearance of this cable is in keeping with modern efficiency of the plant. Simple line tap, permitted by Okonite Dualay construction, serves the 2300/440 volt steel platform substation. Outdoors on poles or indoors where circuits can be carried overhead supported by beams or trusses, Okolite-Okoprene Self-Supporting Aerial Cable provides a dependable and economical method of industrial power transmission.

WEST COAST LUMBER COMPANY follows the modern trend at its new pulp mill—with Okolite-Okoprene Self-Supporting cable. Note the clean appearance of this cable compared with the congestion of the open wiring shown in the inset photo. Space-saving economy, freedom from maintenance and long, trouble-free service throughout the system are advantages provided by this unique Okonite overhead transmission line.

HERE-THERE-EVERYWHERE

OKOLITE-OKOPRENE SELF-SUPPORTING AERIAL CABLE

SAVES | *SPACE*
INSTALLATION COSTS
MAINTENANCE COSTS

Industrial plants everywhere are finding important economies, increased efficiency and better plant appearance by installing Okolite-Okoprene Self-Supporting Aerial Cable. Light weight and great strength mean longer spans—with fewer poles and fittings. Insulated cable reduces congestion of open wiring, eliminates clearance problem near buildings. Okolite insulation and Okoprene sheathing combine to give greater dependability—especially during emergency periods of prolonged wet weather, ice and high wind. Exclusive Dualay* construction (the lay of the twisted insulated conductors is reversed at short intervals) offers additional savings because quick, simple line taps can be taken off at any point, even in mid-span, without disturbing the other conductors or messenger and without using racks or spreaders.

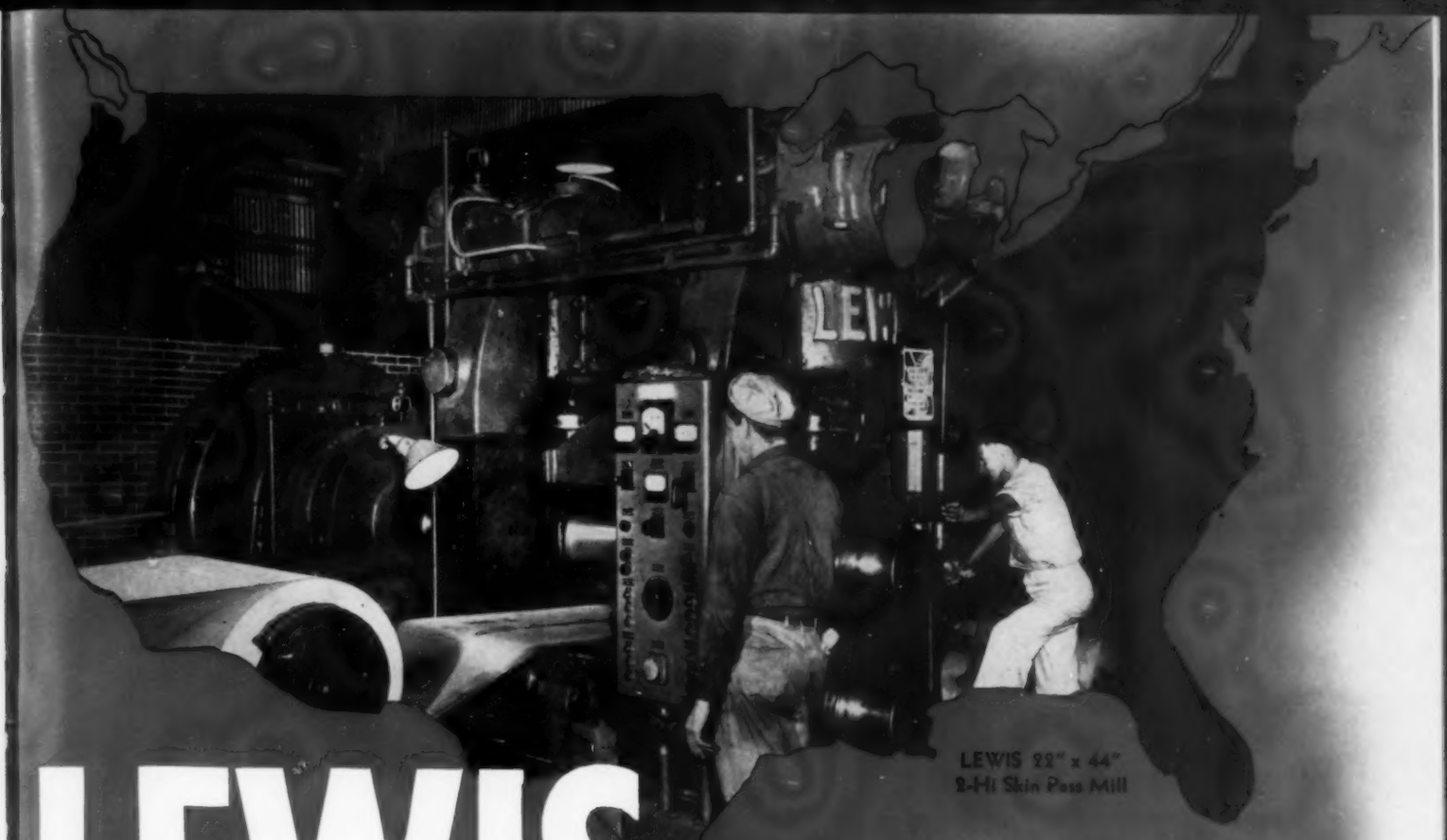
Write for the informative, 52-page manual on Okolite-Okoprene Self-Supporting Aerial Cable. The Okonite Company, Passaic, N. J.

**Reg. U.S. Pat. Off.*

THE BEST CABLE IS YOUR BEST POLICY

OKONITE — SINCE 1878 — *insulated wires and cables*

8186

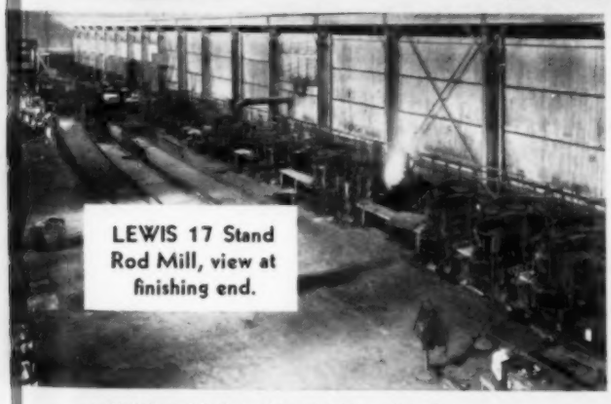


LEWIS 22" x 44" 2-Hi Skin Pass Mill

LEWIS

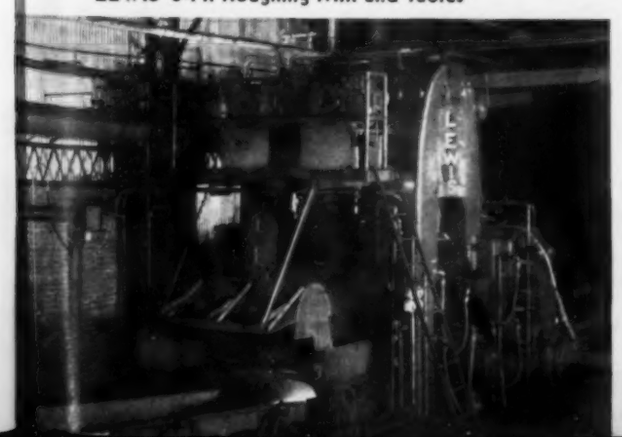
ROLLING MILL EQUIPMENT

...is recognized from coast to coast as the most modern.



LEWIS 17 Stand Rod Mill, view at finishing end.

LEWIS 3-Hi Roughing Mill and Tables



BEDS — Cooling
BLANKS — Gear • Pinion
BOXES — Coupling
CASTINGS — Rolling Mill Furnace
COILERS — Ferrous and Non-ferrous Strip
GEAR DRIVES
GEARS AND PINIONS — Bevel • Double Helical • Single Helical • Speed Reduction • Spur
HOUSING PINION — Rolling Mill
LATHES — Roll Turning
LEVELERS — Roller for Plate and Sheet
MACHINERY — Special • Flaking Mill • Rolling Mill
MACHINES — Pickling
MANIPULATORS — Rolling Mill
MILLS — Aluminum Foil • Bar • Billet and Blooming • Brass and Copper • Cold Rolling • Continuous • Edging • Four-High • Single Stand • Reversing and Tandem • Merchant • Plate Rolling • Precision • Sheet and Strip • Slabbing • Three-High • Tin Plate • Universal • Wire • Zinc Strip • Roughing and Finishing
REELS — Tension
ROLL RAGGING ATTACHMENTS
ROLL POLISHERS
ROLLS — Alloy Iron • Chilled Iron • Sand and Chilled Iron • Steel
SAWS — Hot and Cold
SCREWDOWNS — Motor Operated • Hand Operated
SHEARS — Alligator • Bar • Billet • Bloom • Continuous Automatic • Sheet Mill • Gate or Guillotine • Lever • Plate • Power Driven • Scrap • Vertical
STRAIGHTENERS — Angle • Bar • Rails and Shapes
TABLES — Blooming Mill • Rolling Mill Feed • Transfer for Mills

LEWIS FOUNDRY & MACHINE
Division of Blaw-Knox Co., Pittsburgh, Pa.
Designers and Builders of Rolls and Rolling Mill Equipment

Steel Mill Boosts Quality and Output With Help of Micromax Pyrometers

How can a steel mill engineer invest his Company's thousands of pyrometer dollars, so as to get the greatest dividends from the millions invested in manufacturing equipment?

And how can he surely make his control systems help to the utmost in holding quality, cutting costs and raising output?

Following are some of the answers, taken from a mill which turns out a wide variety of products and where the right temperature control by means of Micromax instruments has proved its worth in many processes.

Continuous Tinning (See Fig. 1)

Uniform temperature in the tin pot helps to maintain uniform rate of deposit, minimum dross formation and maximum production.

Hot Dip Galvanizing (Fig. 2)

Here Micromax Electric Control throttles fuel to the burners. Accurate temperature control means uniform coating, lower consumption of zinc, less maintenance, and less "down time" for drossing.

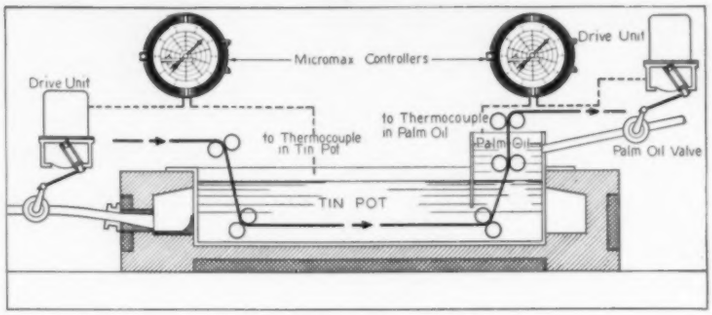


Figure 1. Continuous hot-dip tin pot.

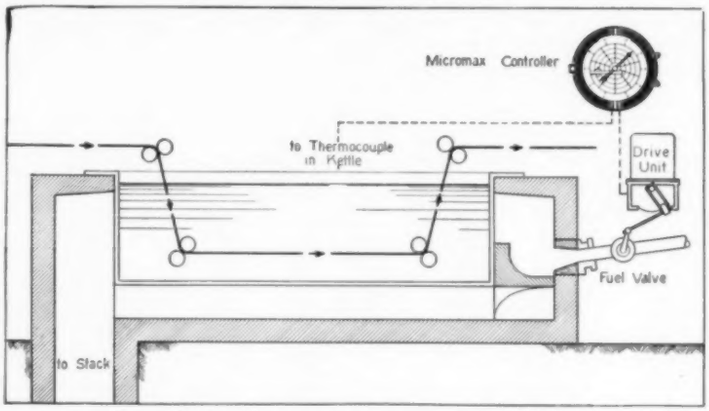


Figure 2. Galvanizing kettle, on continuous sheet line.

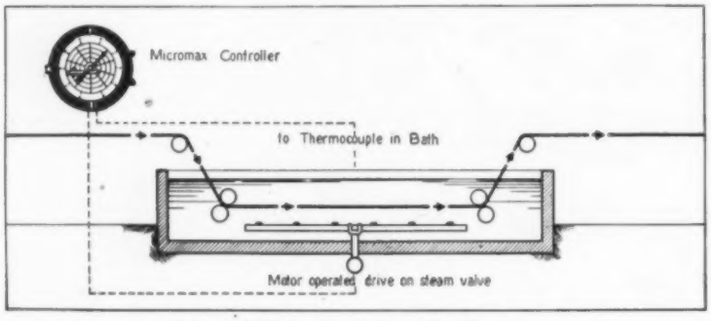


Figure 3. Steam-heated pickling baths.

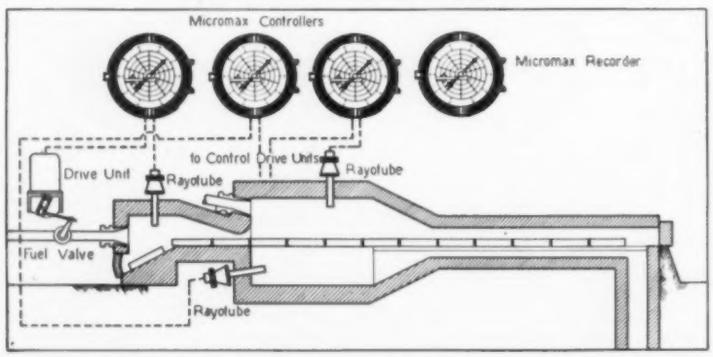


Figure 4. Slab heating furnace. A fourth Rayotube near the one shown in the lower zone detects slab temperature and reports it to the Pyrometer at top right.

Continuous Pickling Baths (Fig. 3)

Here the ability of Micromax to stay on the job continuously, and with low maintenance, helps to keep the process operating at top efficiency a maximum percentage of the time.

Slab Heating Furnace (Fig. 4)

This illustrates the application of Micromax Rayotube Pyrometers to a complex temperature control problem.

Complete temperature control helps the furnace to perform efficiently its functions of bringing the slabs back to rolling temperature, holding them at temperature until the mill is ready to receive them, and finally delivering the slabs at the right time properly conditioned for efficient rolling.

An L&N field engineer is always ready to discuss any temperature control problem with you. Or if a description of the equipment will meet your needs, we'll be glad to send catalogs on request. Address Leeds & Northrup Co., 4942 Stenton Avenue, Philadelphia 44, Pa.

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Which is the Most Important Leg of the Horse?

Obviously, all four legs are equally important. And in designing a steel mill Lubrication System, De Laval pays particular attention to ***each*** of the fundamentals of good engineering practice. The result is that De Laval Lubrication Systems assure completely dependable performance at all times.

PURIFICATION OF LUBRICATING OIL

De Laval Oil Purifiers, furnished as part of the design where possible, are permanently piped to the system to permit centrifugal by-pass purification of the lubricant in service. The Purifiers remove water and fine solid contaminants.

PROPER SELECTION OF PIPE SIZE

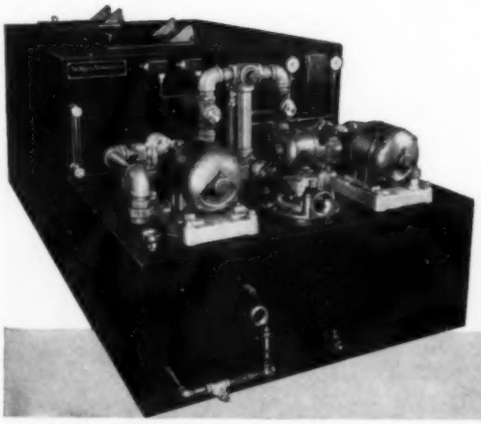
The proper selection of pipe size is important to provide efficient lubrication. All De Laval Systems are designed to keep the pressure drop due to line friction at a minimum, and to insure a streamline flow.

CORRECT METERING OF LUBRICANT

De Laval Systems stress supplying each bearing and gear mesh point with exactly the right amount of lubricant. A constant streamline flow of lubricant in the correct quantity and pressure must be maintained at all times.

EFFICIENT TEMPERATURE CONTROL

De Laval Systems incorporate a constant control of the lubricant temperature both winter and summer. By the use of efficient heating or cooling facilities, a continuous flow of lubricant at the correct temperature and viscosity is maintained.



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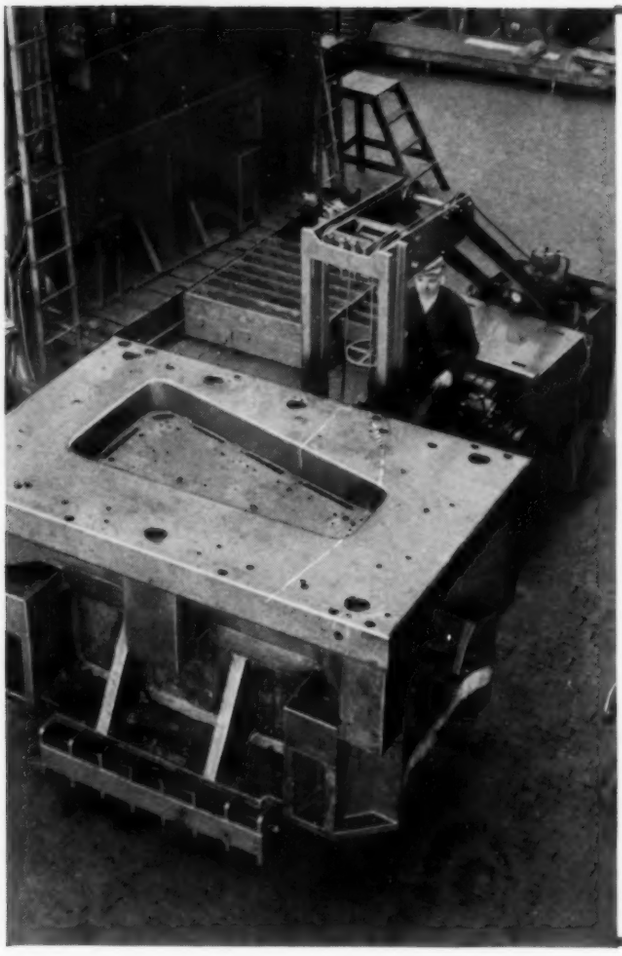

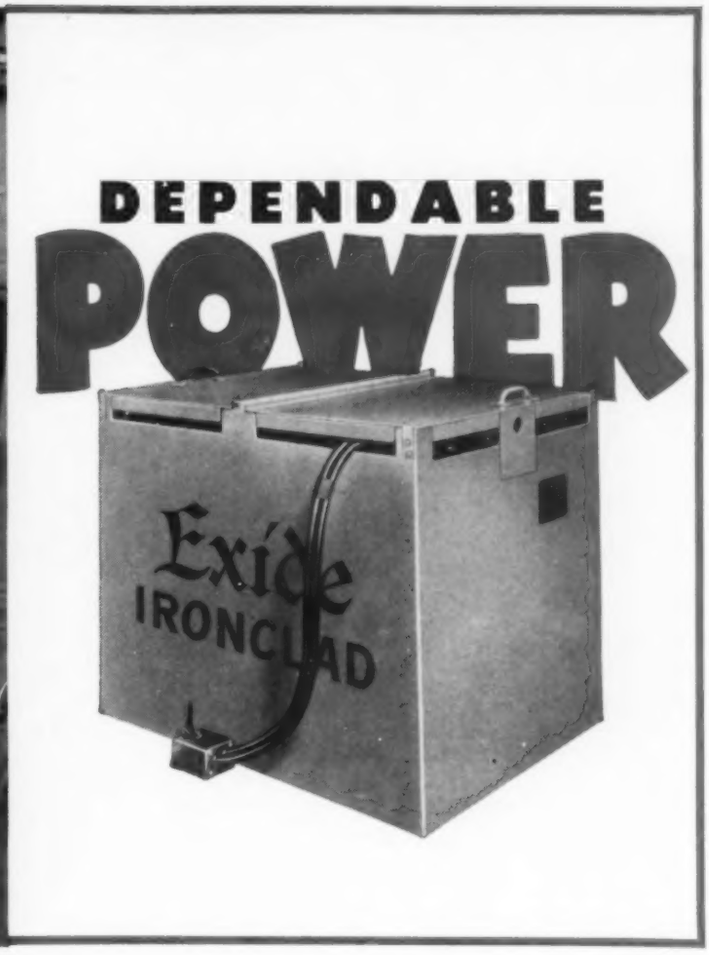

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- full-shift availability, with trucks handling as much tonnage during last hour as first, and at practically no difference in speed.
- high truck availability—freedom from mechanical troubles, and with no unscheduled periods of down time.
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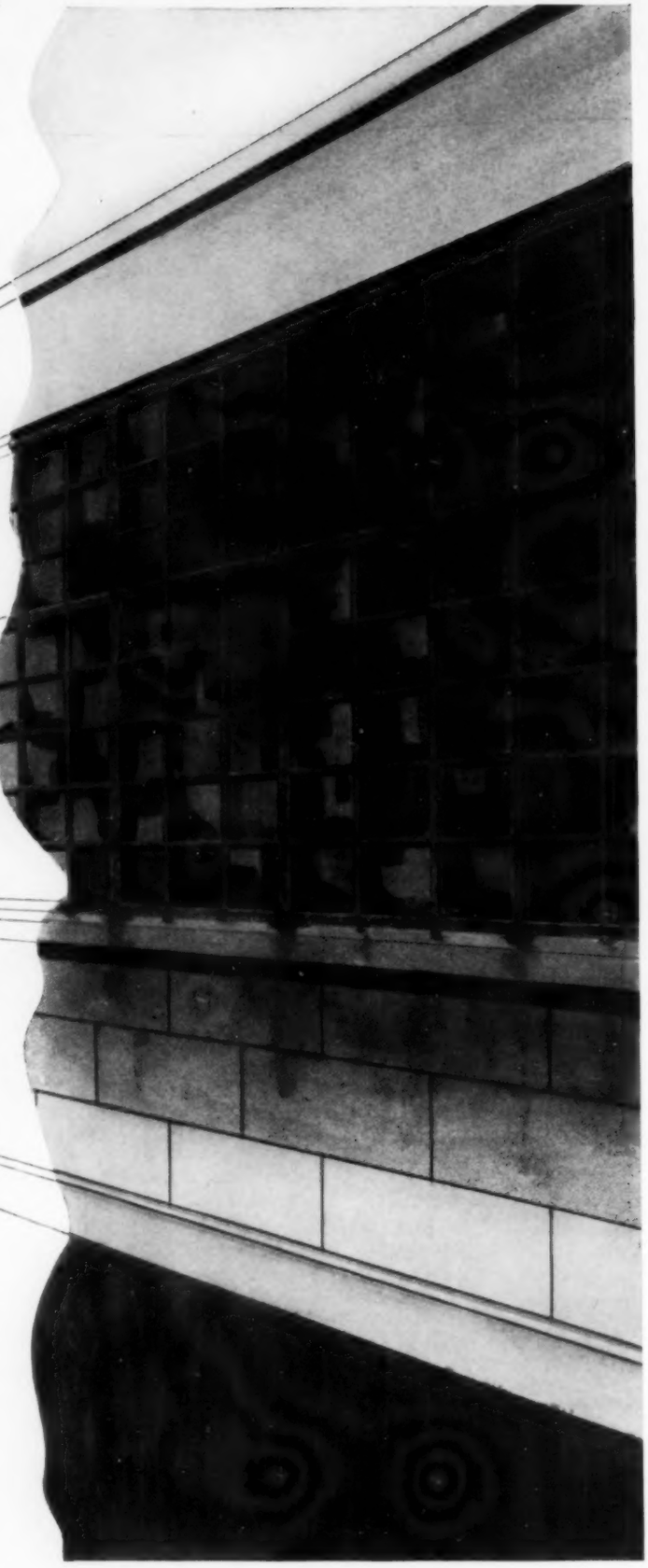

You've often seen unsightly rust stains from metal sash on the adjacent brick and stone surfaces. You need never blame your painting contractor for unsightly stains caused by rust! You can *prevent* rust . . . and at no extra cost . . . simply by specifying RUST-OLEUM as the *shop coat, primer and finish coat* on all metal rust can attack.

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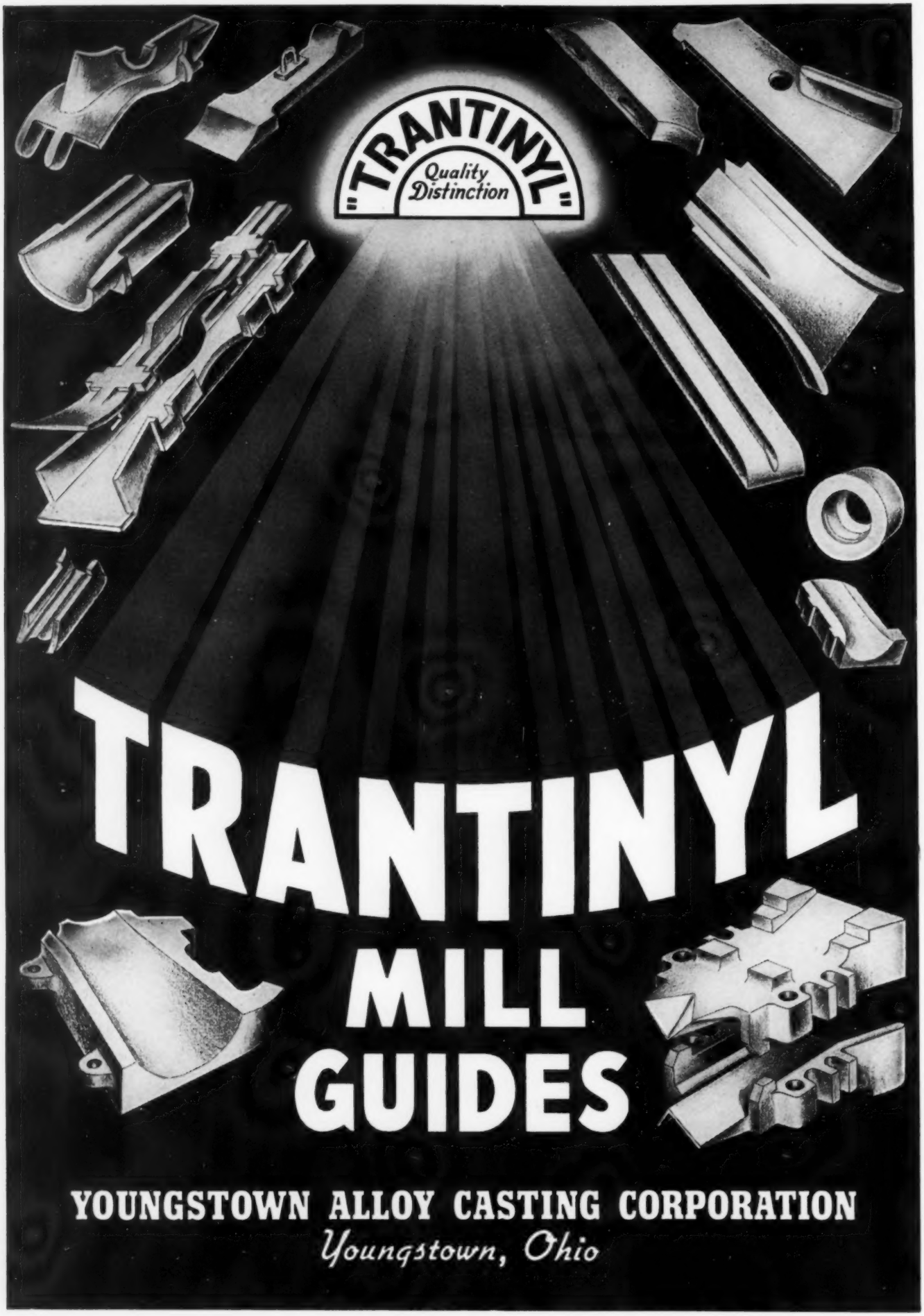
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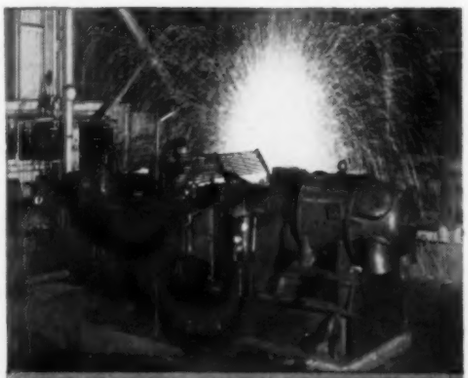

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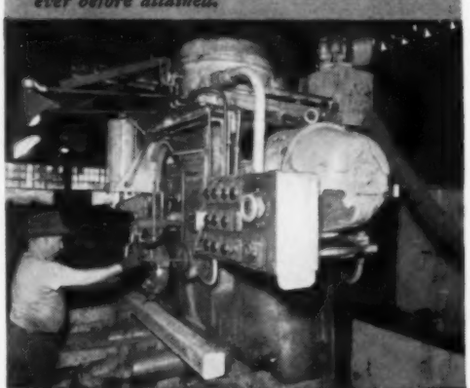

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Evidence of this fact is the ever increasing use of MORGOILS on 2-High and 4-High aluminum foil mills and 4-High reversing and tandem cold mills in the brass and steel industries.

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Loading, Unloading and Conveying Equipment Designed and Built by *Heyl & Patterson*

Nearly three years ago when Alcoa Steamship Company decided to build a Bauxite Ore Transfer Station at Point Tembladora, Trinidad, the planning was a challenge to both Alcoa and Heyl & Patterson Engineers.

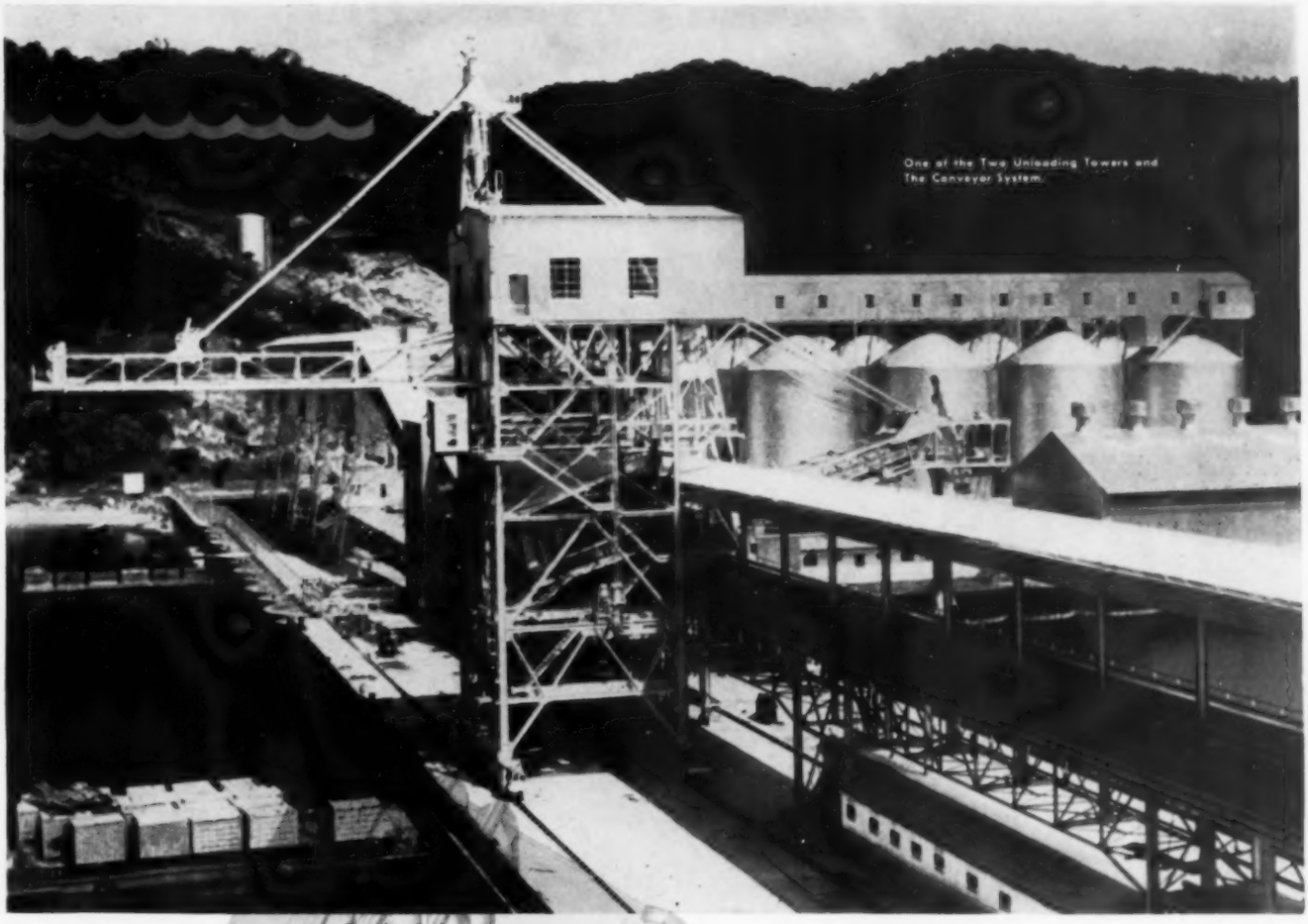
Among the many factors to be considered were: (a) The extremely high cost of power, (b) the need for a high loading and unloading rate, (c) how to keep the bauxite dry, (d) how to handle the peak loads when both unloading towers would be unloading from the same ship, (e) how to control completely all motions of the bucket, (f) how to provide satisfactory voltage over an extremely long runway, (g) how to give the operator in the cab complete visibility, (h) how to assure safety in the hold for the workers helping in the unloading operation, (j) how to keep dust to a minimum.

A Close-up of the Loading Boom, Chute and Trimmer.

With a mutual understanding of the problems, Alcoa and H&P engineers made an organized approach to the study of the equipment and the economies of the handling methods involved. The result is, as shown in the illustrations, the completed Bauxite Ore Transfer Station that loads and unloads bauxite in the fastest possible time . . . at the lowest possible cost.

Like any Heavy Bulk Materials Handling Equipment project that H&P designs and builds, the Loading Tower, the two Unloading Towers and the Conveyor System were individually engineered to meet the successful-operation requirements of Alcoa Steamship Company.

The Loading Tower has a capacity of 2000 tons per hour and the two Unloading Towers, working simul-



One of the Two Unloading Towers and The Conveyer System.

taneously fore and aft, unload shuttle vessels at the rate of 1000 tons per hour.

Each of the Unloading Towers is a rope trolley rig using a 6 ton bucket operating on a 30 second cycle. All motions of the bucket are controlled by varying the voltage generated on each tower. Power is fed to the towers at 440 volt 3 phase 60 cycle. It is converted to variable D.C. voltage for each motion by means of a 28,250 pound Fly Wheel Type MG set. The machinery house, in which the MG set and the bucket and trolley engines are mounted, is located at the top of each tower, 85 feet above dock level.

The operator's cab, carrying all master switches controlling the operation of the tower, is mounted on a heavy ram and is moved out over the hold of the vessel over which the Tower is working. Whenever the Tower is to be moved from one vessel to another the Cab can be retracted to its traveling position immediately against the front portal. The operator of the Cab has a full view of the hold at all times and thus is able to guard against the bucket hitting anyone who may be working in the hold.

Since Bauxite must be kept dry, ordinary methods of keeping dust to a minimum by sprinkling could not be used. The space above the hopper where the bucket is dumped is completely enclosed, top and three sides, with only the front being left open to permit entrance of the bucket. All chutes and transfer points are covered.

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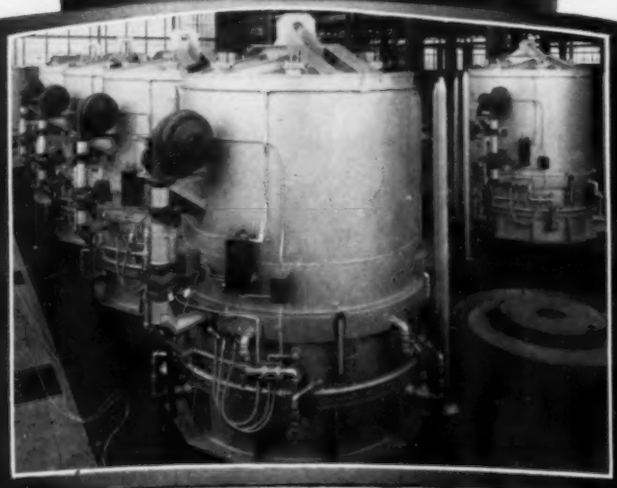

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Timken roll neck bearings give longer trouble-free life than other roll neck bearings. Timken balanced proportion design permits larger diameter roll necks than ever before possible with tapered roller bearings, giving greater mill rigidity. Roll neck strength is increased 50 to 60% and load ratings are increased up to 40%.

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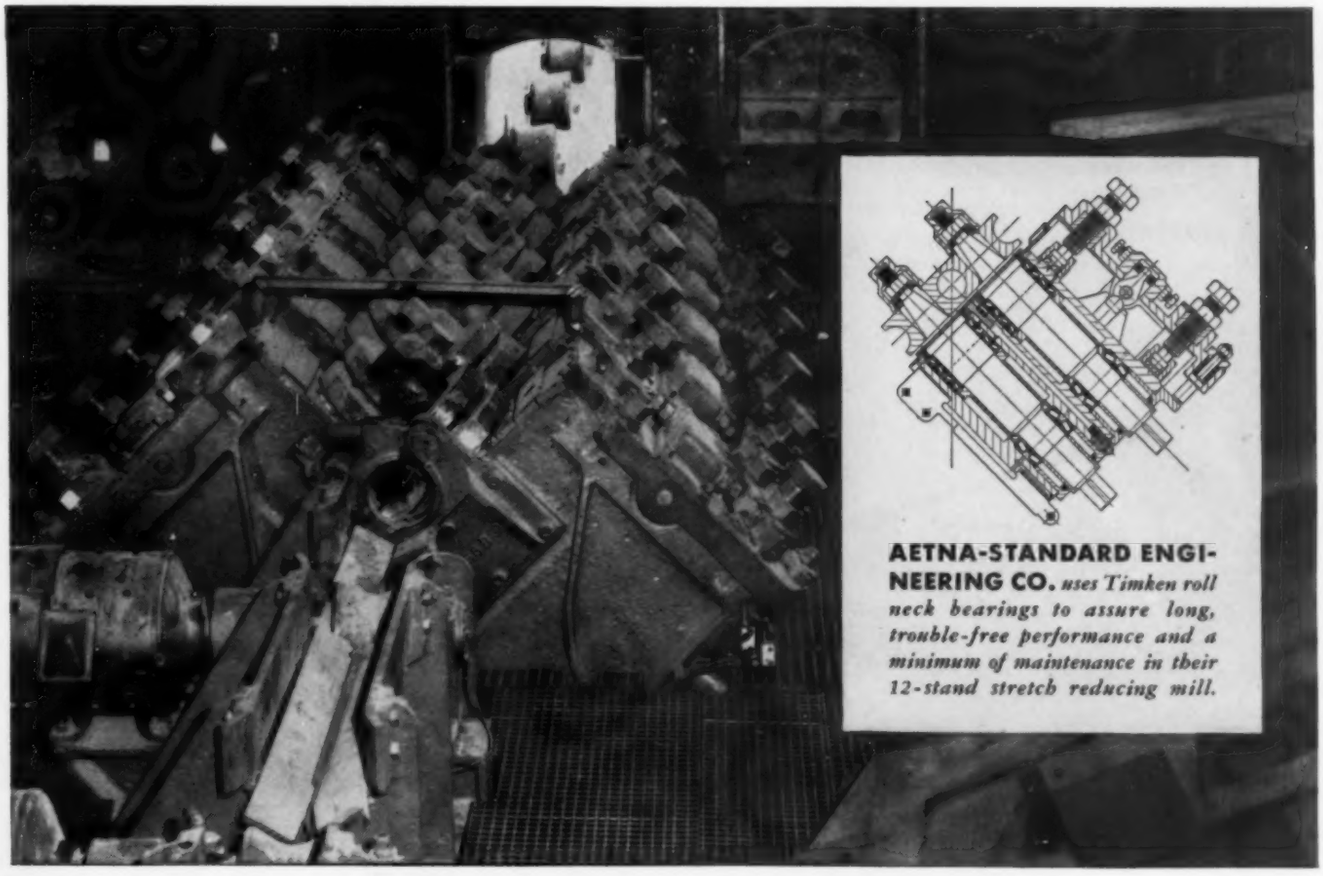
You can get all these advantages now in new or existing equipment with Timken balanced proportion roll neck bearings. For full information, consult our roll neck bearing specialists. Write The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



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TAPERED ROLLER BEARINGS

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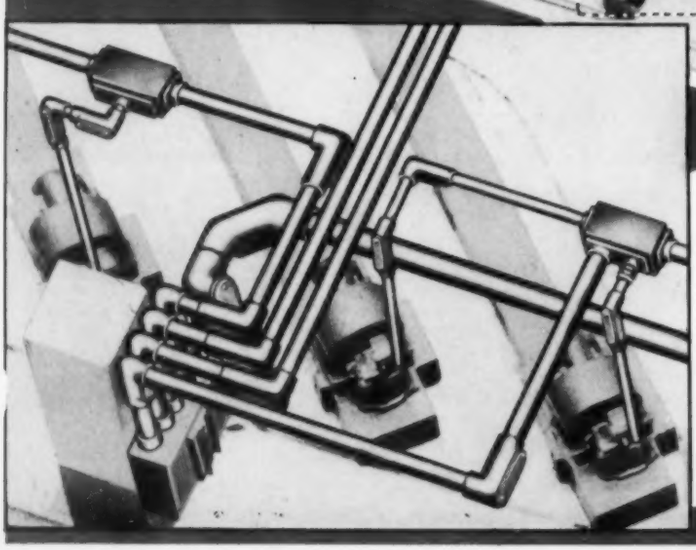
for MODERN WIRING... the conduit and CONDULET*

RS Series Junction Conduits take detachable hub plates with 1, 2, or 3 hubs for conduit from ½" to 3¼"

THE "NEW LOOK" IN CONDULET INSTALLATION

A model of a screw machine department with a modern layout of cast Feraloy Condulets and rigid conduit. It has flexibility plus all the other Condulet advantages. The actual installation has been in service for several years and is highly satisfactory.

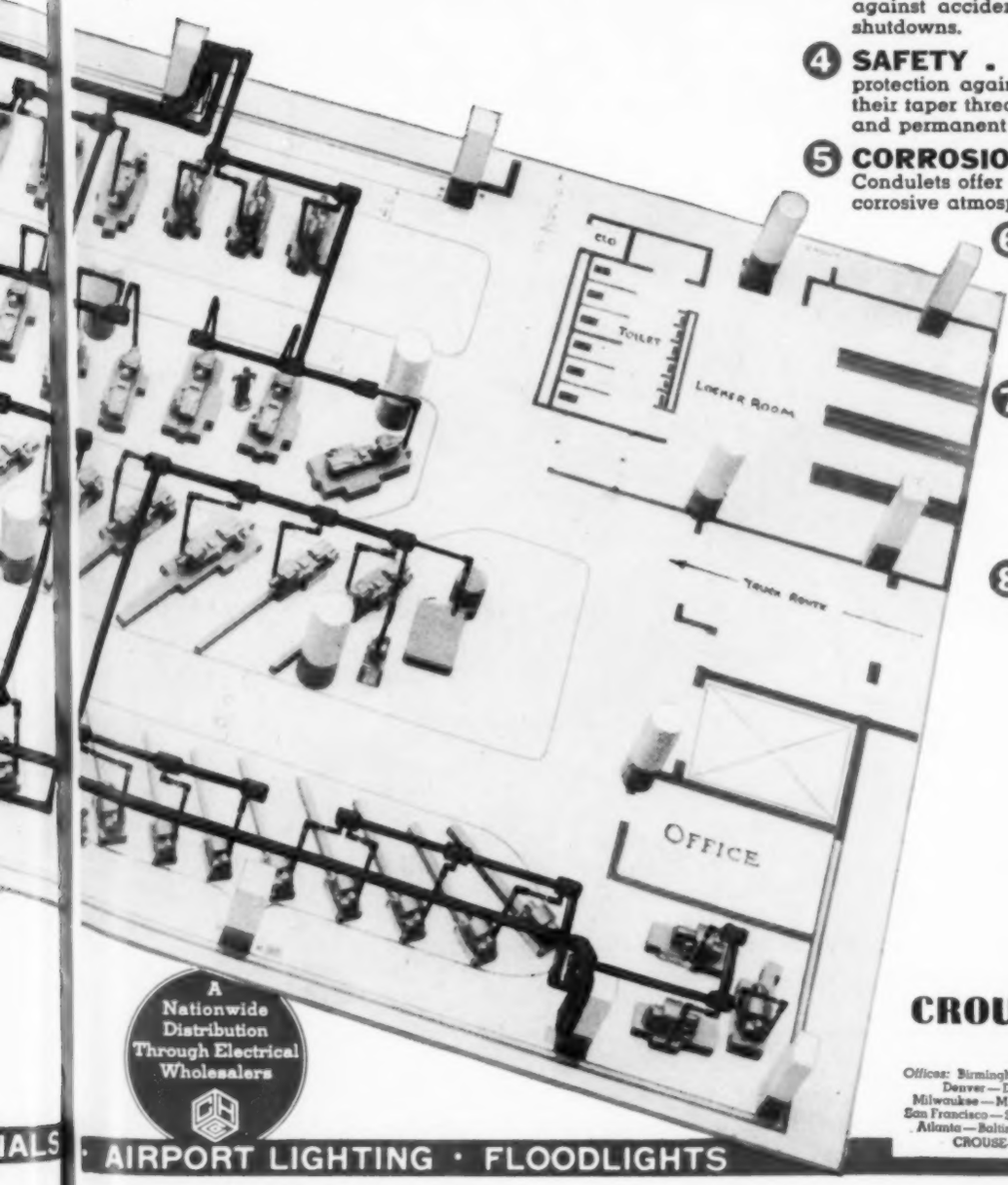


Enlarged view, showing how Type RSM Condulets provide for easy expansion . . . branch circuits can be added at any time. Simply replace a blank plate with a plate that has the required number and size of hubs.

CONDULETS · TRAFFIC SIGNALS

method gives YOU definite advantages!

NEW ways of using the familiar Condulet and conduit material have produced outstanding results. Modern installation layouts meet industry's modern needs for flexibility while retaining the enduring protection and safety that can only be given by cast Feraloy Condulets and rigid conduit.



1 FLEXIBILITY . . . A modern Condulet installation, like the one illustrated below, provides for the vigorous growth and changing conditions of a modern industry. The RS Series Condulets with their detachable hub plates make it easy to change circuits or add additional circuits at any time.

2 UNIVERSAL APPLICATION . . . Galvanized Condulets and galvanized rigid conduit may be used under all atmospheric conditions and occupancies.

3 MECHANICAL PROTECTION . . . Cast Feraloy Condulets and rigid conduit provide the best possible protection against accidental damage to the wiring — prevents costly shutdowns.

4 SAFETY . . . A Condulet installation gives maximum protection against personal injury and fires. Condulets with their taper threaded hubs and rigid conduit provide a reliable and permanent low resistance path to ground.

5 CORROSION RESISTING . . . Cast Feraloy Condulets offer the best protection wherever moisture, dust or corrosive atmospheres are present.

6 ECONOMY . . . Direct comparison of Condulet and rigid circuit installations with other wiring methods show comparable installed costs. The durability, safety, and low maintenance cost of Condulet installations produces savings which pay dividends over the years.

7 QUALITY . . . All Condulets are built to Crouse-Hinds' high standard of quality with painstaking care by skilled craftsmen. Thousands of Condulet installations that are still in active service after twenty, thirty, forty or more years offer positive proof that the trademark CONDULET stands for reliability and long life.

8 VARIETY . . . Thousands of types and sizes of Condulets, plugs and receptacles, and lighting fixtures are listed in the Condulet Catalog, including a complete explosion-proof and dust-tight line for use in hazardous locations. There is a Condulet for every purpose.

On your next electrical layout, whether modernization or new construction, plan to get all of the benefits of sturdy cast Feraloy Condulets and rigid conduit. Send for additional information on modern Condulet installation.

* CONDULET is a coined word registered in the U. S. Patent Office. It designates a product made only by the Crouse-Hinds Company.

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MODERN ALL-WELDED STEEL MILL CRANES

Crops and Shorts

PLANS announced by various steel producers will add an annual steel tonnage of 6,363,000 tons to the national capacity during 1950, 1951 and 1952. This includes new open hearth furnaces for Carnegie-Illinois Steel Corp. and Jones & Laughlin Steel Corp. in Pittsburgh; for Inland Steel Co. and Youngstown Sheet & Tube Co. in Chicago, and for the new United States Steel Corp. plant at Trenton, N. J., as well as furnace enlargement programs by Republic Steel Corp. and others.

According to the American Iron and Steel Institute, national capacity stands at 100,563,500 net tons of steel per year as of July 1, 1950, an increase of some 1,175,000 tons since the first of the year. A capacity of 105,750,000 tons per year is expected by the end of 1952.

▲

THESE expansion programs were planned before the Korean situation developed. Many other improvements, however, which had only been in the conversational stage or which had been projected and then shelved for one reason or another, have crystallized since the Asiatic unpleasantness broke out. Already, steel plant equipment manufacturers report an influx of orders, and there is much more to come.

▲

AT the same time, steel companies have been deluged with orders for steel. Many of these are nothing but building up inventories in expectation of allocations to come, and can be put in the same class as the actions that have cleaned out the sugar shelves of stores in some areas — they want to get some before the hoarders get it all. The steel industry is acting wisely in refusing to book much of this tonnage until government needs are better known.

▲

A SMALL quantity of taconite concentrate, said to be three or four cars, arrived in Cleveland recently, mixed in with other ore consigned to Youngstown Sheet and Tube Co. The concentrate came from the Pickands, Mather & Co.'s pilot plant at Aurora, Minn. The process reduces three tons of taconite rock to one ton of pellets of about 65 per cent iron content.

▲

OVERHEARD in a Chicago-Pittsburgh club car recently:

"The greatest economic blow ever suffered by the United States was the failure of a St. Louis haberdashery."

"Oh, I don't know. If the haberdashery hadn't failed, we might have Henry Wallace as president."

▲

IN Detroit recently, a baker was hailed into court for selling 20 oz loaves of bread with 16 oz labels on them. Government regulations say he can't do that, because that would be unfair competition. Instead, he must sell 16 oz loaves at a uniform stated price. Yet the same practice to which the baker must adhere is criminal if done by large corporations. The steel industry, among others, is being accused of monopolistic practices and price-fixing for allegedly doing exactly what the baker must do by statute.

As we've said before, what's sauce for a little goose isn't sauce for a big one.

▲

SOMEONE gives us a definition of salary as a sum of money approximately half of what you're worth. And here we thought it was a sum of money just slightly less than your expenditures.

▲

A PROSPECTUS for Western Steel Enterprises, Ltd., states that the company has an agreement with the government of Western Australia for the lease of certain iron ore deposits on Koolan Island, Yampi Sound, W. A., and for the lease of certain coal deposits at Collie, W. A. One subsidiary, Western Rolling Mills Pty. Ltd., will immediately begin construction of facilities for making steel from purchased pig iron and scrap, and for rolling light steel sections.

Another subsidiary, Westeel Pty. Ltd., will begin investigation of modern steel making methods, of cost and lay-out of an integrated plant, and of manufacturing costs.

A third subsidiary is to investigate the suitability of coal from the company's deposits for the purpose of steel production. This may include research into alternative fuels and into newly developed processes of iron production for which coking coals are not required.

It is expected that much of the engineering and equipment will be obtained in the United States.

▲

SOMEONE tells us that you can measure a man's troubles by the number of keys he carries around in his pocket. We've always thought of ourselves as relatively carefree, but not counting automobile keys, our key-ring has nine on it — or should we count the bottle-opener, too?

▲

DOWN in Alabama, the chambers of commerce of Anniston and Gadsden erected a bill board that says:

Every Time The Sun Sets
Your Federal Government
Is $15,000,000
Deeper in Debt.
How Long Can This Last?

We don't know how long it can last, but in the light of recent developments, we'd say there was a prospective job for a painter there, revising the numerals.

WAGNER MOTORS
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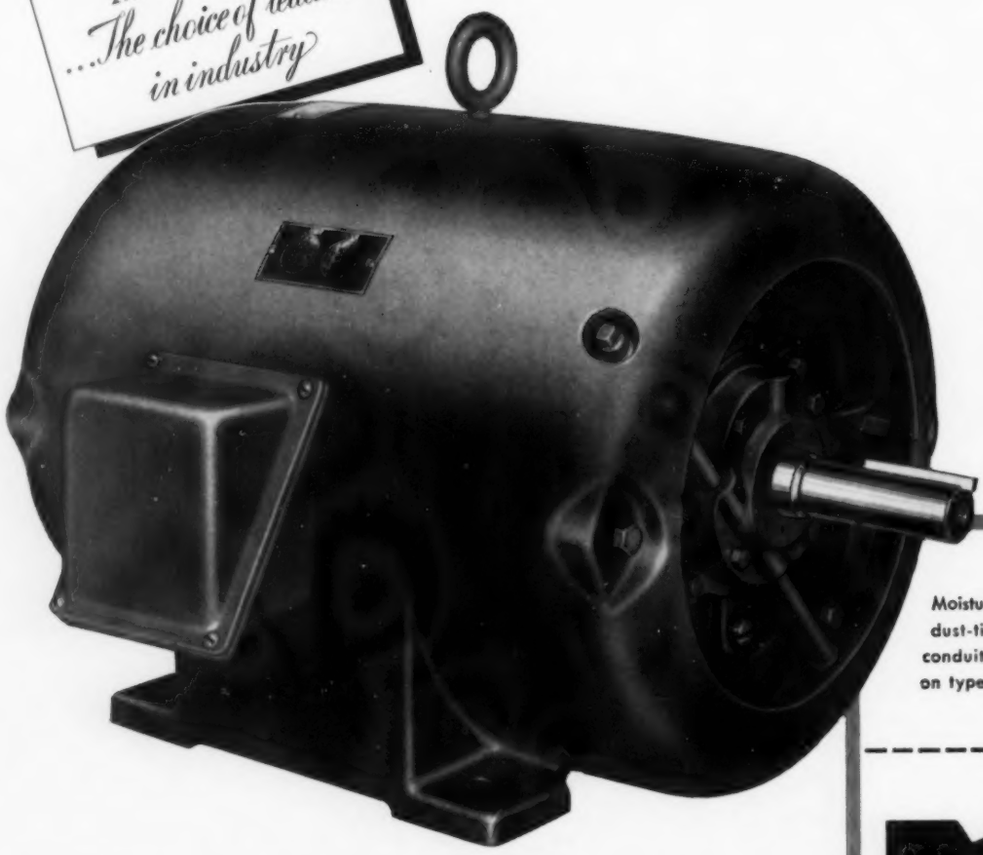
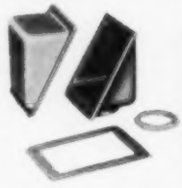
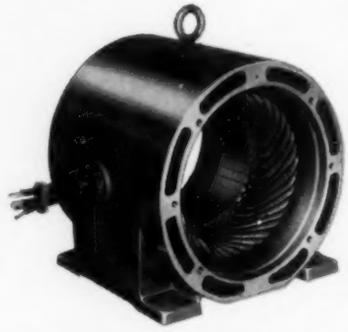


IT'S WAGNER *because:*



Moisture-proof and dust-tight cast iron conduit box—screw-on type.

Leads are brought out through threaded nipple and sealed with a flexible compound.



Rugged, corrosion-resistant cast iron frame with inner frame, outer frame and feet cast in one piece.

Wagner Cast Iron Frame Motors

resist the damaging action of acids, fumes, moisture and other destructive elements

Motors used in chemical manufacturing plants, oil fields, coal mines, and in similar applications where corrosion is a problem must be designed to resist damage by acids and alkalies present in the atmosphere in the form of dust, fumes, or moisture.

Wagner cast iron frame motors are built to provide the corrosion-resistance demanded by such applications. They feature well-impregnated, special varnish treated windings protected by totally-enclosed fan-cooled construction . . . a cast iron, gasket sealed conduit box . . . and drain plugs in the endplates for easy removal of any condensation from inside the motor.

These motors are available in ratings from 5 to 250 horsepower, in both standard (type EP) and explosion-proof (type JP) designs.

Bulletins give full information on Wagner Cast Iron Motors and on other motors in Wagner's complete line. Thirty-one branches, located in principal cities, are ready to assist you whenever you have a motor problem.

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M50-22

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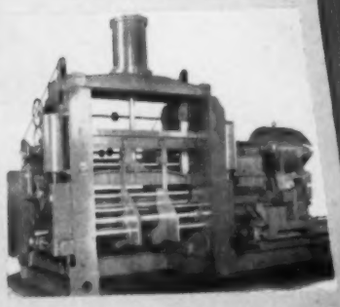
WARREN, OHIO

Continuous Strip Pickle Line

Processing Uncoiler



Continuous Electrolytic Cleaning Line

Continuous Hot-Dip Galvanizing Line

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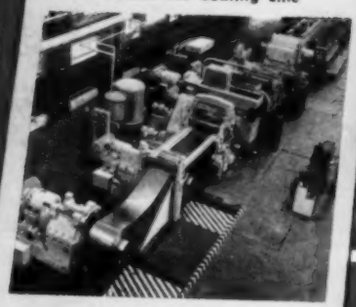
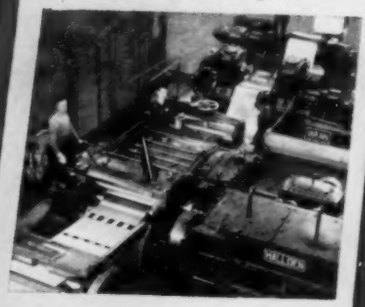


Tin Plate Shearing Line



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Mechanized Sheet Mill

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Iron and Steel ENGINEER

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In This Issue

Electrical Equipment for Cold Rolling and Finishing Department — by M. A. Leishman, Electrical Superintendent, Steel Co. of Canada, Ltd., Hamilton, Ontario 35

Electrical Drive for 56-In. Five-Stand Tandem Cold Reduction Mill — by Ralph A. Harvie, Application Engineer, Canadian Westinghouse Co., Ltd., Hamilton, Ontario 43

Program 1950 Annual Convention and Iron and Steel Exposition 51

Rail Slitting Mill — by C. W. Barrett, Chairman, Bar Mill Committee, Republic Steel Corp., Cleveland, Ohio 59

Design and Maintenance of Crane Runways — by V. L. Smith, Assistant to Chief Engineer, Fort Pitt Bridge Works, Pittsburgh, Pa 67

Couplings for Rolling Mill Drives — by Walter P. Schmitter, Chief Engineer, The Falk Corp., Milwaukee, Wis 71

Technical Program of the American Iron and Steel Institute 81

New Blooming, Bar and Billet Mills of Lorain Works — by A. F. Eisel, Chief Roll Designer, United Engineering and Foundry Co., Pittsburgh, Pa. 100

New Power for Bethlehem's Sparrows Point Plant — by J. M. Spencer, Assistant Fuel Engineer, Bethlehem Steel Co., Sparrows Point, Md 108

Natural Gas Gives Flexible Combustion Control — by W. A. Stermer, Industrial Engineer, The Manufacturers Light and Heat Co., Washington, Pa 122

General Electric Hot Rolls Stator Frames 124

Date Line Diary 133

Industry News 137

Personnel News 153

Equipment News 171

Index to Advertisers 177

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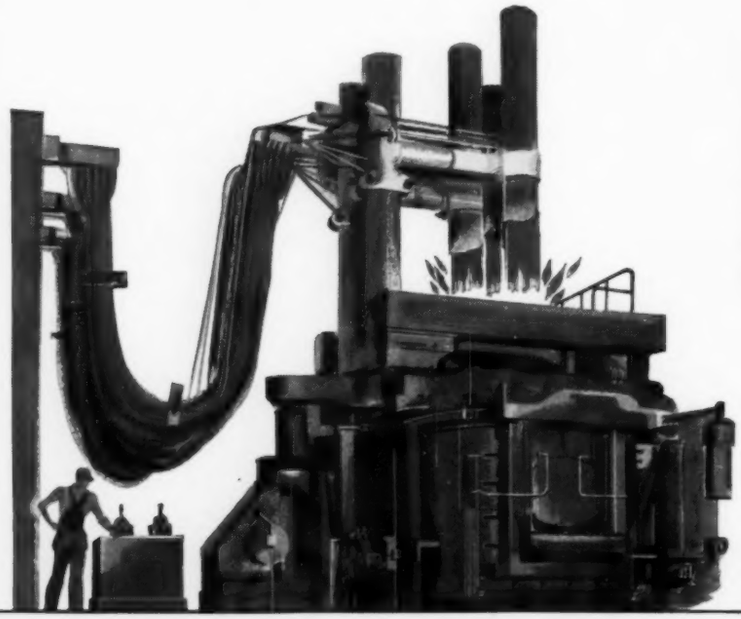

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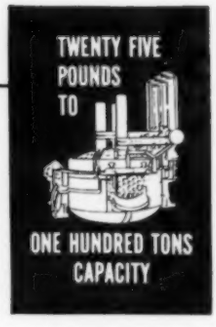


Electrical Equipment for

COLD ROLLING AND FINISHING DEPARTMENT

By M. A. LEISHMAN
Electrical Superintendent
Steel Company of Canada, Ltd.
Hamilton, Ontario

. . . . this line is the first tandem cold rolling mill to go into operation in Canada . . . . mill speed is 3300 fpm for tin plate and sheet . . . .

▲ THE completion of the cold mill at the Steel Company of Canada, Ltd., has rounded out a program begun several years ago to build a complete new hot and cold strip mill. The first stage saw the 110-in. plate mill and plate finishing mill put into operation early in the year 1941. Towards the latter part of 1945, the 56-in. hot strip and finishing department went into production. Then construction was started on the cold rolling and finishing departments in June, 1947, units of which first began operating in September, 1948.

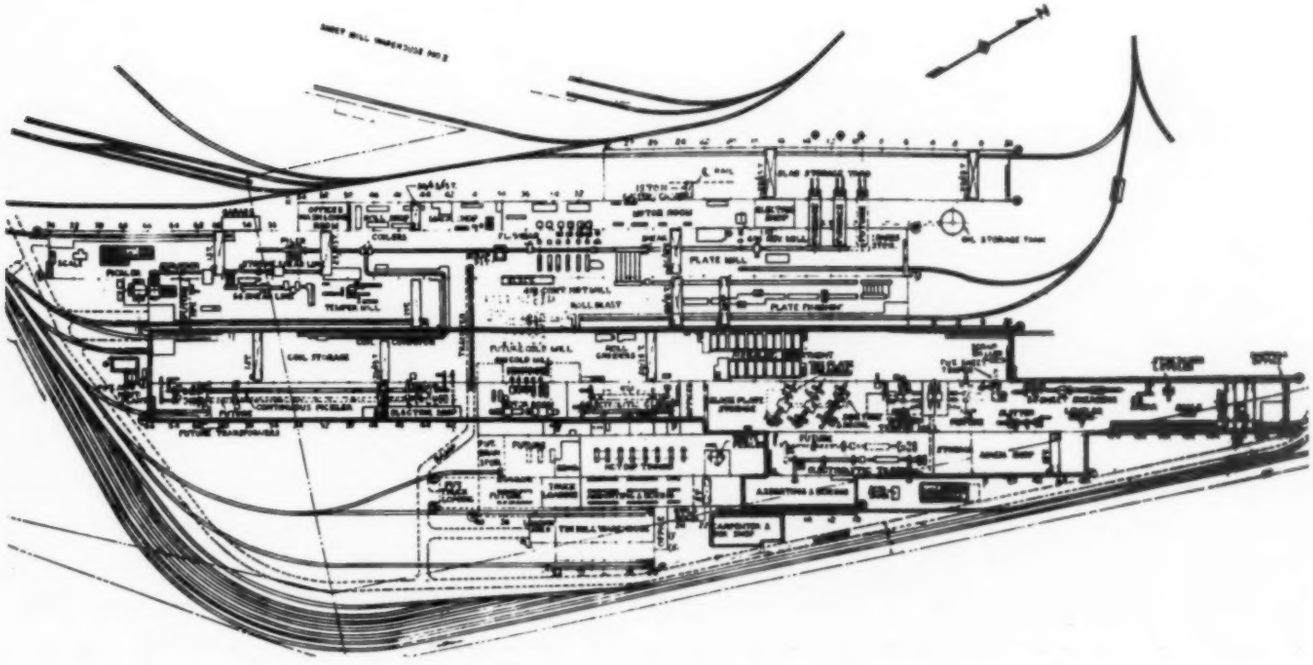
The new units comprise a pickling line, a five-stand 56-in. cold reduction mill, a 52-in. electrolytic cleaning line, annealing furnaces, a two-stand 56-in. temper mill, two tin plate cutting-up lines, a side trimming line, and a sheet shear line. At present, an electrolytic tinning line is being built. Figure 1 shows a general layout of the hot and cold strip mills. That portion of the layout, enclosed by the heavy line shows the extent of the new cold strip reduction and finishing mill.

The complete layout of the hot and cold strip mill buildings shows an area totalling 22.8 acres; of this the cold reduction and finishing mill building extensions make up 10 acres.

ELECTRIC POWER SUPPLY

Electric power supply to this latest extension is at 13,200 v, 3-phase, 25-cycle from the public utility substation direct by underground cables to the cold mill substation "CM," located at the main cold mill motor room. As in the earlier installed hot mill, the larger

Figure 1 — General layout of hot and cold strip and sheet mill and electrolytic tinning plant.



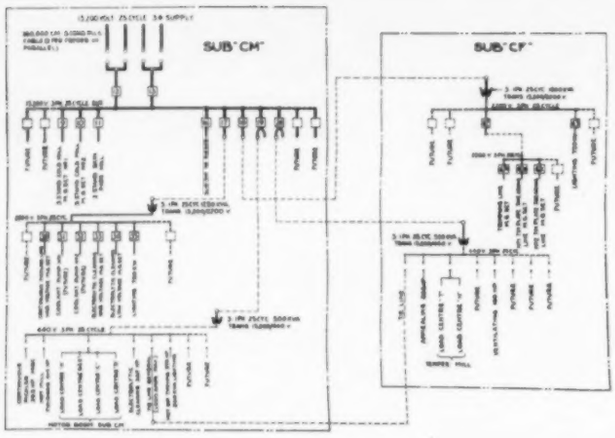


Figure 2 — Power line schematic diagram for cold rolling finishing mills.

main drive motor-generator set motors of 3000 hp and over have been designed for 13,200 v. Intermediate motor sizes of 200 hp and over and lighting distribution transformers use power at 2300 v, 3-phase, and all smaller auxiliary motors use 440 v, 3-phase. To supply power at these lower voltages, two distribution centers have been established—one at substation "CM" and the other at the cold finishing, substation "CF." At substation "CM" are a 3750-kva, 13,200/2200 and a 1500-kva, 13,200/440-v transformer bank; while at substation "CF" are a 4500-kva, 13,200/2200-v and a 1500-kva, 13,200/440-v transformer bank.

A supply of 250 v d-c for crane power and the comparatively small amount of constant voltage d-c load in the cold mill section comes from the two 1000-kw generators, already installed at the hot mill substation.

Figure 2 is a one-line power diagram and shows the various feeder lines from substation "CM" and "CF." All inter-connection between these two stations is by underground duct. Generally speaking, nearly all secondary voltages are carried underground also, but, wherever it proves practicable, roof lines are used.

Table I shows the motor connected load for the cold rolling and finishing department.

The cold mill department buildings cover approximately 438,200 sq ft. The general lighting of the aisles is furnished by 1000 watt high bay prismatic glass lighting units. In all, 1300 kva of 2200/220/110 v lighting transformer capacity has been installed, the total lighting load, at present, being about 700 kw for this section, which equals 1.6 watt per sq ft of floor area.

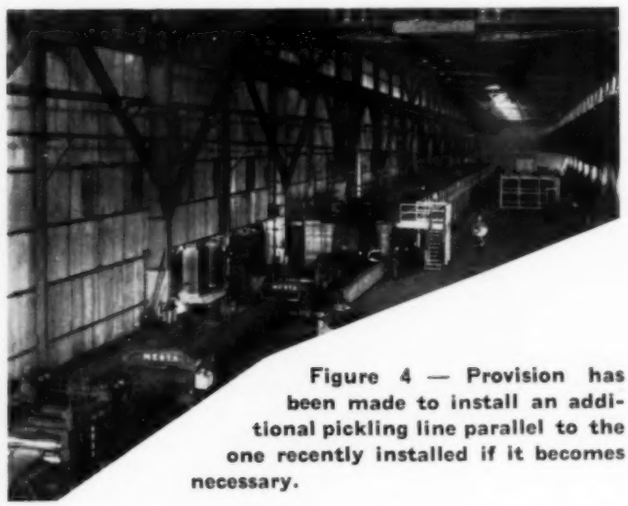
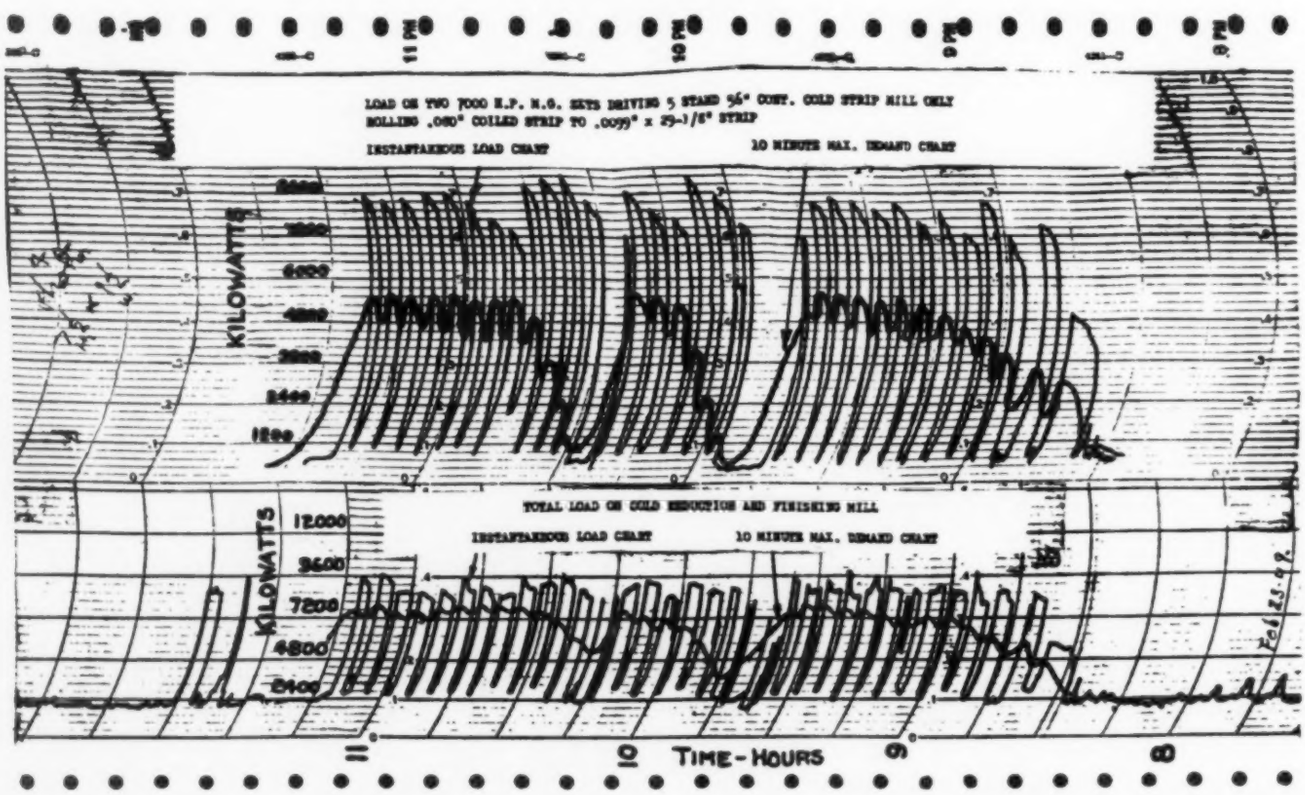


Figure 4 — Provision has been made to install an additional pickling line parallel to the one recently installed if it becomes necessary.

Figure 3 — Oscillograph record of load demand shows how important a factor the tandem cold mill is in setting overall requirements.



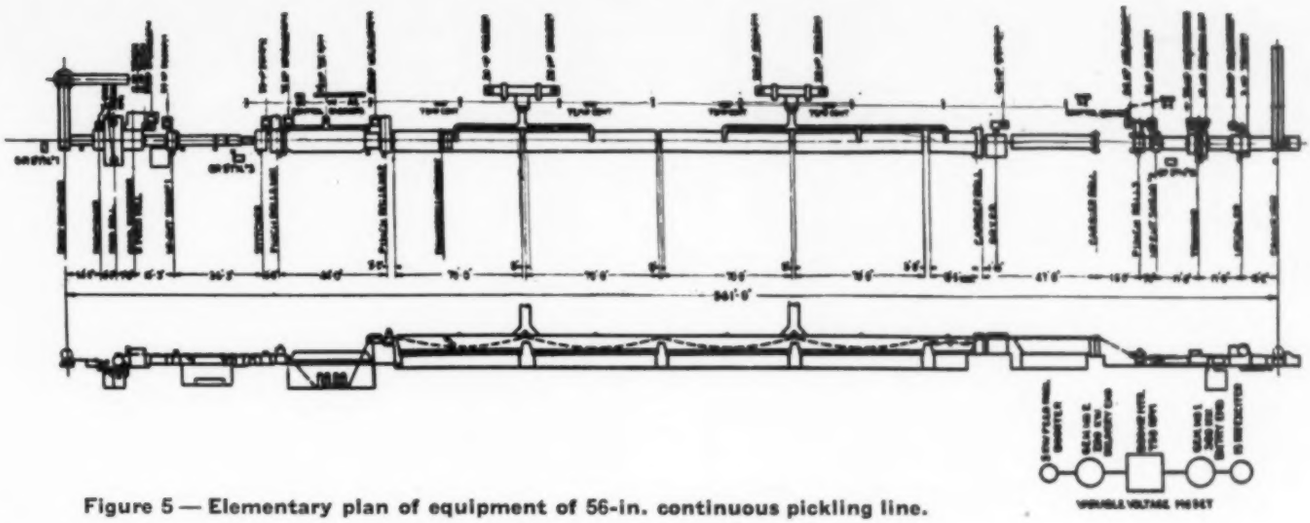


Figure 5 — Elementary plan of equipment of 56-in. continuous pickling line.

TABLE I

Summary of Electric Motors

Cold Rolling and Finishing Department Connected Load

Department	25 Cycle						Isolated d-c				General	
	13,200 V		2300 V		440 V		600 V		230 V		230 V d-c	
	Hp	Units	Hp	Units	Hp	Units	Hp	Units	Hp	Units	Hp	Units
56-In. Continuous pickling line			900	1	332	22			520	8	30	2
5-Stand mill	15,000	2			586	42	12,000	5	813	9	500	10
52-In. Electrolytic cleaning line			500	2	364	15			463	11		
Annealing					828	103						
No. 1 tin plate shear line			200	1	51	10			183	12		
No. 2 tin plate shear line			200	1	38	7			165	4		
Side trim and recoil line			200	1	143	10			195	5		
2-Stand temper mill	3,000	1			326	21	2,550	5	752	8	218	6
54-In. Sheet shear line					188	8			203	7	25	1
Machine shop and miscellaneous					413	59			35	2	121	17
Cranes											1149	33
Hot dip tin mill (Constructed in 1940)					470	55			60	8		
Totals	18,000	3	2000	6	3739	352	14,550	10	3389	74	2043	69

TABLE II

Speed Data — Continuous Pickling Line
Line Speed — Entry End — 780 Fpm at 275 Volts
Line Speed — Delivery End — 368 Fpm at 250 Volts

Application	Hp	Nameplate ratings		Additional ratings		Diam of roller knife, in.	Total gear ratio	Matching conditions			Connection to generator No.
		Rpm	Volt	Rpm	Volt			Line speed, fpm	Motor rpm	Motor volt	
No. 3 feed reel	7½-10	300/1200	250	330/1320	275	20 60	8.0:1	780	1190 396	275	1
Processor main drive	250	850/1065	230	1015/1275	275	15⅛	6.4:1	780	1200	275	1
Pinch rolls	75	1150/1440	230	1375/1720	275	16	8.0:1	780	1495	275	1
No. 1 drive pinch rolls	60	1150/1440	230	1250/1565	250	14	13.67:1	368	1375	250	2
No. 2 drive pinch rolls	60	1150/1440	230	1250/1565	250	14	13.67:1	368	1375	250	2
No. 3 drive side trimmer	50	1150/1725	230	1250/1875	250	16.5 14.5		368 368	1350 1535	250 250	2 2
Drive upcoiler	50	1150/1725	230	1250/1875	250	6.5	1.167:1	368	1340	250	2

TABLE III

5-Stand Tandem Mill

Stand No.	Work roll		Back-up roll		Roll stand centers ft-in.	Gear ratio	Fpm		Motor		Motor generator set, kw
	Diam, in.	Length, in.	Diam, in.	Length, in.			Min	Max	Hp	rpm	
1	21	56	53	55	.....	0	385	965	1500	70/175	1250
2	21	56	53	55	13-0	0	688	1376	2500	125/250	2000
3	21	56	53	55	13-0	0	965	2200	2500	175/400	2000
4	21	56	53	55	13-0	0	1238	2880	2500	225/525	2000
5	21	56	53	55	13-0	0	1376	3400	3000	250/625	2500
Reel	....	....	....	....	10-8	0	.....	.....	800	175/700	750

All cables of 2000 volt insulation and over are installed lead covered and terminated in potheads. Low voltage cable installed in basement floors or in underground ducts, or in damp locations are also lead covered. Multi-conductor lead covered control cable with number coded wires has been used extensively for interconnecting control wiring.

The maximum ten minute demand of connected load shown by Figure 3 of the cold strip rolling and finishing department is 8,692 kw. This does not include the 250 volt shop supply and overhead crane load. Maximum peak kw loads average approximately 9500 kw. Figure 3 graphically illustrates not only the loading of this whole department, but also shows what a very large part the 5-stand tandem cold mill plays in setting the peak.

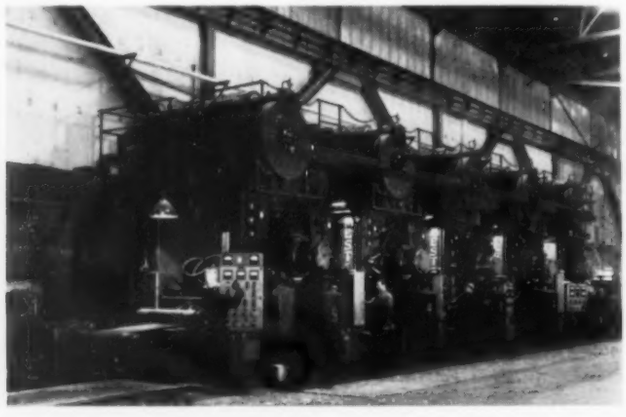


Figure 6 — The 56-in., 4-high, 5-stand tandem mill was designed to roll a wide range of product.

Figure 7 — The motor room is combined with substation "CM."

PICKLING LINE

Coils leaving the hot mill coilers range, at present, up to 8000 lb with an inside diameter of approximately 23 in. These coils of strip steel for the cold mill move by coil conveyor from the hot strip coilers across the hot finishing aisle, along the coil storage section of the cold mill aisle. Here, the coils are stored until ready to be moved through the pickling line process onto an approach conveyor by overhead crane.

Figure 4 shows a view of the pickling line from entry end. A single line is now installed, with provision made for another line parallel with the first. The pickling line is 560 ft overall length with four acid tanks each 70 ft long x 5 ft 7½ in. wide x 4 ft 1½ in. deep inside the brick, and one water rinse tank 19 ft 5 in. long x 6 ft

Figure 8 — Individual 600-v, d-c generators were used to supply the power for each main drive motor.

Figure 9 — The mill stand switchboards are located in the basement.

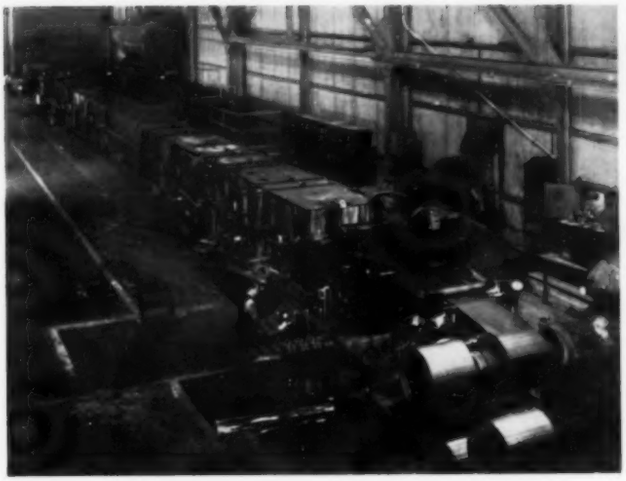


Figure 10 — Provision was also made to install an additional electrolytic line adjacent to the one just installed if that is found necessary.

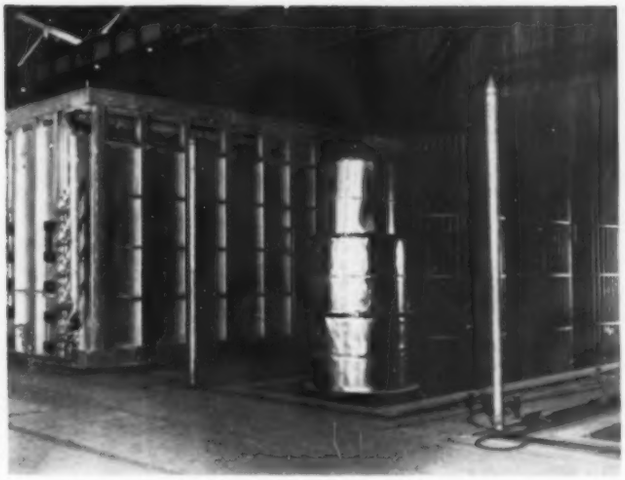


Figure 12 — Seven portable radiant tube furnace covers are used with 18 bases in the present annealing setup.

3½ in. wide x 2 ft 9⅛ in. deep. Space has been arranged for a future acid and rinse tank. The tank construction is of welded steel, lined with acid brick and rubber. Four 30-hp motor driven fans furnish ventilation. The line is variable voltage speed controlled, having designed maximum entry and delivery speeds of 780 and 368 fpm, respectively. Coils entering the pickling line are joined together by stitcher process; provision, however, has been made to install a welder in the future. Convenient to the pickling line drives but inside the cold mill motor room is the variable voltage motor generator set and entry tension regulating set together with the related control switchboard.

Figure 5 is a diagrammatic view of this pickling line. Table II shows various main drive motors. There has been no attempt in Figure 5 or remaining diagrams of processing lines to show all a-c motors or all operating stations. As will be noticed, the control for the entry end of this line is situated opposite the looping pit. Control for the finishing end is located in the cold mill motor room adjacent to the variable voltage motor-generator set. Power and control cables from this motor room, which is located adjacent to the delivery end of the line, are run in an underground duct from the motor room to the entry and control cabinet cubicles.

5-STAND TANDEM COLD MILL

Coils leaving the delivery end of the pickling line are 19½-in. inside diameter. These are transferred by battery truck to the coil box of the five-stand tandem cold mill. See Figure 6. This mill is a 56-in. 4-high tandem cold reduction mill. The mill was designed to roll a rather wide diversity of strip ranging from 22 to 52 in. in width, from 0.110 to 0.075 in. thick entering the mill, and reducing to finished gages of 0.075 to 0.006 in.

The motor room (Figure 7) for this mill together with the main switching equipment are combined in one cold mill substation "CM" which is 175 ft long, 102 ft wide, including an annex 32 ft wide. The ceiling height above the mill floor is 15 ft 6 in., which allows the aisle servicing crane to travel on its runway 36 ft 0 in. above the floor to either end of the aisle and, as well, permits this same crane to handle any lifts required in the motor room through removable sections in the false roof of the motor room.

To meet the close speed matching of the stands for the rather wide range of strip products to be rolled and to minimize off-gage material as well as any tendency to tear strip, careful consideration was given to the electrical drive. See Figure 8. The decision reached

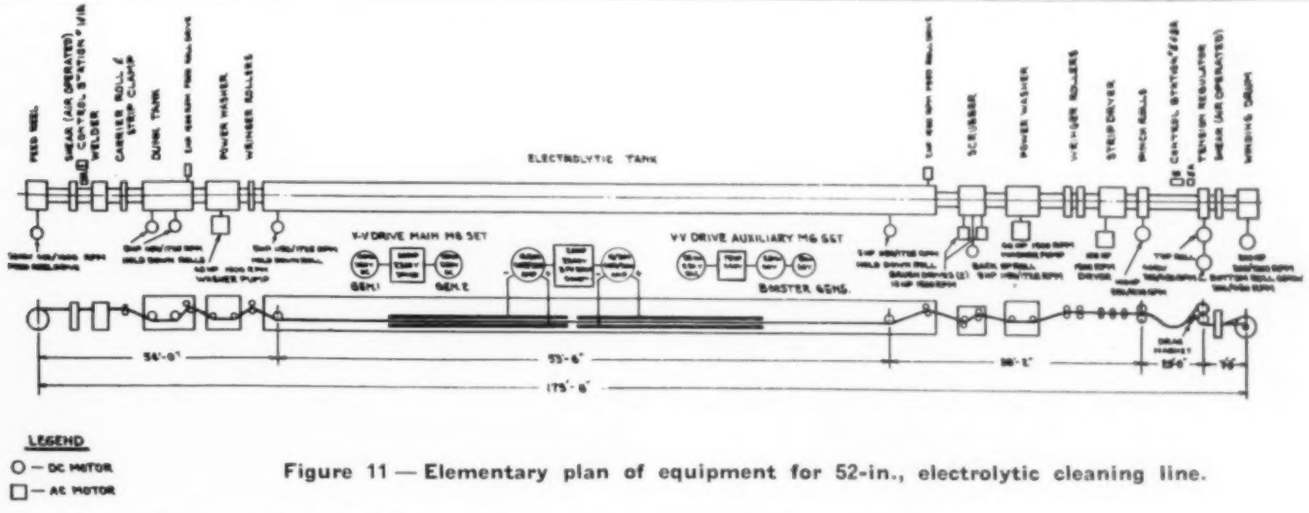


Figure 11 — Elementary plan of equipment for 52-in., electrolytic cleaning line.

TABLE IV

Electrolytic Cleaning Line Speed Data

(2000 Fpm at 275 Volt — Variable Voltage Control)

Application	No. of motors	Nameplate ratings			Rpm at 275 volt	Diam of coils or rolls, in.	Total gear ratio	Matching conditions			
		Hp	Rpm	Volt				Line speed, fpm	Motor rpm	Motor volt	
Feed reel — payoff and drag	1	30 kw	400/1600	250	440/1760	20 60	4.0:1	2000	1530 510	275	
Hold-down rollers	4	5	1150/1725	230	1375/2060	30	6.28:1	2000	1595	275	Generator
Scrubber—back-up roll	1	5	1150/1725	230	1275/2050	18	3.85:1	2000	1630	275	No. 1
Pinch rolls	1	100	850/1275	230	1015/1520	10	1.57:1	2000	1200	275	
Tension regulator top roll drive	1	40 kw	300/450	250	330/495	18.75	Direct	2000	410	275	
Tension regulator bottom roll drive	1	60 kw	300/450	250	330/495	18.75	Direct	2000	410	275	Generator No. 2
Winding drum main drive	1	200	300/1200	230	360/1435	20 60	3.58:1	2000	1370 455	275	

was to use individual 600-volt, d-c generators to supply the power for each main drive motor. Also, at the comparatively high maximum delivery speed of 3400 fpm, successful operation of the mill demands that the inertia of rotating parts be kept to a minimum. For this reason, the design of the drives resulted in the double armature motor type for the last two stands and reel. All motors and reel are directly connected to pinion stands which gives a very clean cut job. Table III shows the fundamental characteristics of this 5-stand tandem mill. As the electrical control equipment is described by Mr. R. A. Harvie in the following paper, no attempt will be made in this paper to describe the operation of the mill.

The mill stand 600-volt, d-c switchboards are located in the substation basement between the main drive motor-generator set foundations and the main drive motor foundations. This is illustrated in Figure 9. As each mill stand switchboard is conveniently located between its associated motor and generator, all control wiring for each individual switchboard is brought from the mill operator's control cabinets to a junction box mounted adjacent to each switchboard for convenience in making interconnections. At the mill operator's cabinets, control cables are sealed off with conduit type potheads, thus preventing moisture or oil getting into cables and conduits.

Ventilation of the cold mill motor room is by a down draft, air recirculating system. The heated air from the machines discharges downward into an air tunnel. This tunnel extends from end-to-end through the motor foundations with a bank of air cooling units at each end. In a similar manner, an air tunnel extends from end-to-end of the large main drive multi-generator motor-generator set foundations. The air going into these tunnels divides and is drawn through the cooling units at each end and into the basement by five motor driven fans. These fans discharge the cooled air upwards through ducts into the motor room proper. In this way, a total of 205,000 cfm of air may be recirculated. In addition, one 33,000 cfm fan is arranged to draw air from the outside mill roof for make-up supply and to keep the motor room under a slight air pressure. In order that a certain percentage of the motor room recirculated air be filtered, one of the recirculating fans and the make-up air fan are arranged to draw air through an electrical precipitator type air cleaning unit of 70,000 cfm capacity. In this way, it is hoped to minimize the accumulation of floating dust in the motor room.

THE 52-IN. ELECTROLYTIC CLEANING LINE

One line has been installed for the present with provision for one other. Coils of 20-in. inside diameter from the 5-stand tandem cold mill are brought to the cleaning line entry end by battery truck. This line, illustrated in Figures 10 and 11, is controlled by variable voltage with a maximum speed of 2000 fpm. Both the main and booster motor-generator sets, as well as master control board for the line, are situated in the 5-stand cold mill motor room. The electrolytic low voltage motor-generator set is centered on and within 10 ft of the cleaning tanks. Motor control is adjacent to the line with the two units located at the entry and delivery ends. Line speed data is given in Table IV.

ANNEALING FURNACES

The present installation (Figure 12) comprises seven portable radiant tube annealing furnace covers, each 26 ft-8⅜ in. long, 17 ft-4⅜ in. wide, 17 ft-¾ in. high overall, and eighteen bases. Each base has four 7½ hp motor driven air recirculating fans and one 5 hp motor driven cooling fan. Great care was taken in the location of receptacle outlets at each base, and it was found practicable to supply these along the building column lines. Motor controls for these bases and covers are installed in basements which run the full length of the annealing sections.

Combustion controls are situated along column lines. Pyrometers are of the electronic type and have proved satisfactory.

2-STAND TANDEM 4-HIGH 56-IN. TEMPER MILL

For the exacting process of temper rolling strip, the control of this mill follows much the same pattern as that for the five-stand cold mill, in that the mill motors are each powered through an individual generator of

Figure 13 — A 2-stand, 4-high, 56-in. tandem mill is used for temper rolling.

tension devices, the payoff and reel controls transfer over to current or tension regulators. When the threading operation is completed, and the operator presses the "tension" button, the tension regulator drives change to current or tension control. At the same time, stand No. 1 is changed to tensiometer control, or, at the operator's discretion, may be left as a speed controlled drive. These two alternatives provide for greater flexibility of the mill. When the transfer has been made, the entire drive is taken up to speed by individual generator control.

The control switchboard and the main drive motor-generator set with its exciter sets are situated in a motor room adjacent to the mill. See Figure 14.

As previously mentioned, substation "CF" was built to serve as a load center for the cold finishing section. This station, which is a separate building, was also located so as to provide a source of supply for clean filtered air, and therefore, one end of the building was

TABLE V

56-In. Temper Mill

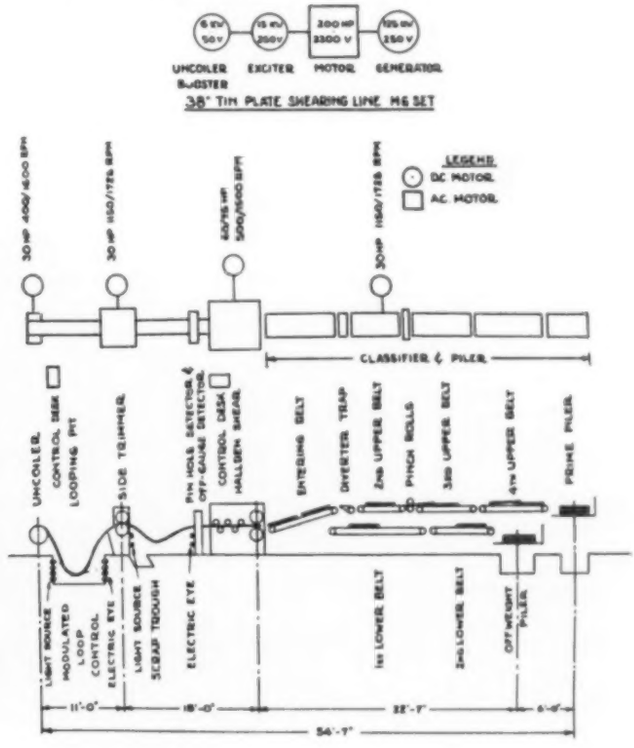
Stand No.	Work roll		Back-up roll, in.	Roll stand centers, ft-in.	Gear ratio	Fpm		Motor		Motor generator set
	Diam, in.	Length, in.				Min	Max	Hp	Rpm	
Payoff	20	....	.....	.....	2.84:1	2530	3000	2-75 kw	50/1500	200 hp
Entry tension	20	....	.....	6-6	1.68:1	2530	3000	100 kw	450/900	225 hp
Stand No. 1	12	56	53	6-1	0	2730	3000	75 kw 700 hp	460/920	600 kw
Stand No. 2	21	56	53	13-0	0	2790	3000	1000 hp	250/535	850 kw
Delivery tension	20	....	.....	6-1	1.59:1	2810	3000	350 hp	450/900	400 kw
Reel	20	....	.....	6-0	2.16:1	.....	3000	150 hp 350 hp	450/900	350 kw

a main motor generator set with each drive unit having a regulation exciter set for its own control. See Figure 13.

Table V shows the speed matching characteristics of this mill. From a control standpoint, all drives are speed controlled from stand No. 2 while threading. As tension is established between payoff and entry tension devices and also between the reel and delivery

Figure 14 — Control switchboard and main drive motor generator set for temper mill.

Figure 15 — The line speed of the 38-in., tin plate shearing line can be varied from 250 to 1200 fpm. Coil sizes run 20 in. inside diameter x 60 in. outside diameter by 38 in. wide maximum.



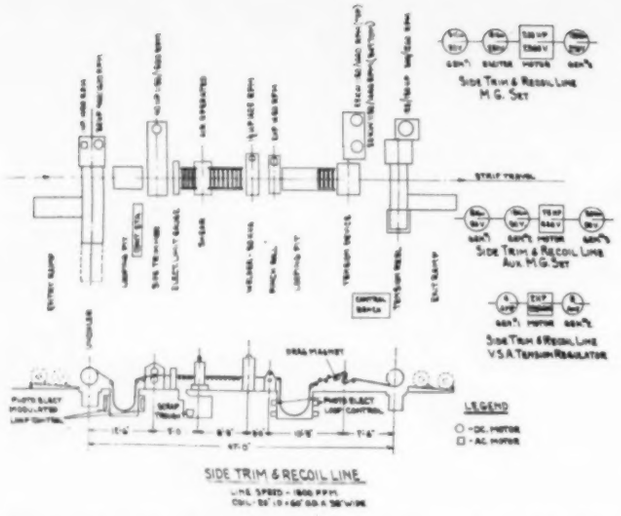


Figure 16 — Elementary plan of equipment of side trim and recoil line.

designed as a fan and air filter room. Air is pulled through a viscous oil revolving screen and is forced by two 30,000 cfm fans through a tunnel to the basement of the temper mill motor room, and thence up through the generators and motors.

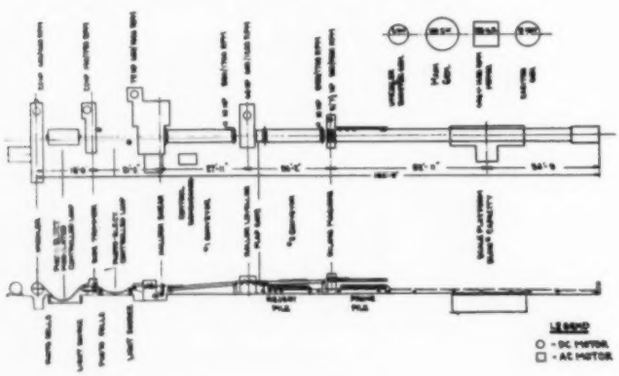
TIN PLATE RECOIL AND SHEARING LINE

One 38-in. recoil and two 38-in. shearing lines on approximately 40 ft centers and at an angle of 60 degrees to the column line, were installed and are illustrated by Figures 15 and 16. The lines operate on variable voltage. The motor-generator sets and control are situated in an electrical basement 40 ft x 100 ft, below the entry end of the lines.

54-IN. SHEET SHEAR LINE

This line also operates on variable voltage and is illustrated in Figure 17. The control for this line is situated on a mezzanine with the motor-generator set below, between the line and the building columns. This layout was designed to take care of a future line along side the present installation.

Figure 17 — The 54-in., sheet shear line has a maximum speed of 350 fpm. It can cut materials in thicknesses of 0.012 to 0.074 in. in lengths from 36 to 244 in.



GENERAL

Cranes—The main cold mill aisle, with its coil storage at one end and the annealing furnace toward the other, is served by three electric overhead traveling cranes with 96 ft-0 in. spans, one 15-ton crane for coil handling, one 25/15 ton at the mill area proper, and one 50/15 ton annealing crane. This latter crane has the operator's cab mid span of the crane girder.

The general servicing of the pickling line and cleaning line aisle is handled by a 30/50/15 ton crane of 66 ft-0 in. span. This crane also takes care of the cold mill motor room requirements.

In the cold finishing department aisle are two cranes 96 ft-0 in. span, one of 25/15 ton capacity and the other used primarily on the shipping floor, of 15-ton capacity.

One 15-ton crane, 78 ft-6 in. span serves the machine shop and will serve the electrolytic tinning line.

Floor trucks—Battery trucks are used extensively in the handling of strip coils and sheets. This equipment consists of four ram type trucks 18,000-lb capacity and one fork truck 18,000-lb capacity. Each of these trucks is equipped with power steering for ease of manipulation. It is of interest to note that floor areas used by all trucks have been designed for 30,000-lb trucks.

For servicing these battery trucks and charging batteries, an electrical shop has been constructed at one end of the pickling line aisle. This enclosure has a 5-ton floor operated service crane for handling batteries and equipment.

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ELECTRICAL DRIVE FOR 56-IN. FIVE-STAND TANDEM COLD REDUCTION MILL

By RALPH A. HARVIE
Application Engineer
Canadian Westinghouse Co., Ltd.
Hamilton, Ontario

. . . . the tandem mill is driven through a separate generator system with fast response rotating speed regulators to synchronize the speeds of the 5 stands . . . .

▲ THE electrical drive for the Steel Company of Canada 5-stand tandem mill was the first such drive to be designed, built and installed in Canada for the continuous rolling of cold finished tinplate and sheet. It was also the first of a number of similar mill drives, built by my company, to go into operation using the separate generator system. It was also the first mill of its kind to go into operation using a speed regulating system for matching stand speeds, with speed intelligence furnished by tachometer generators driven from the mill motor drive shafts.

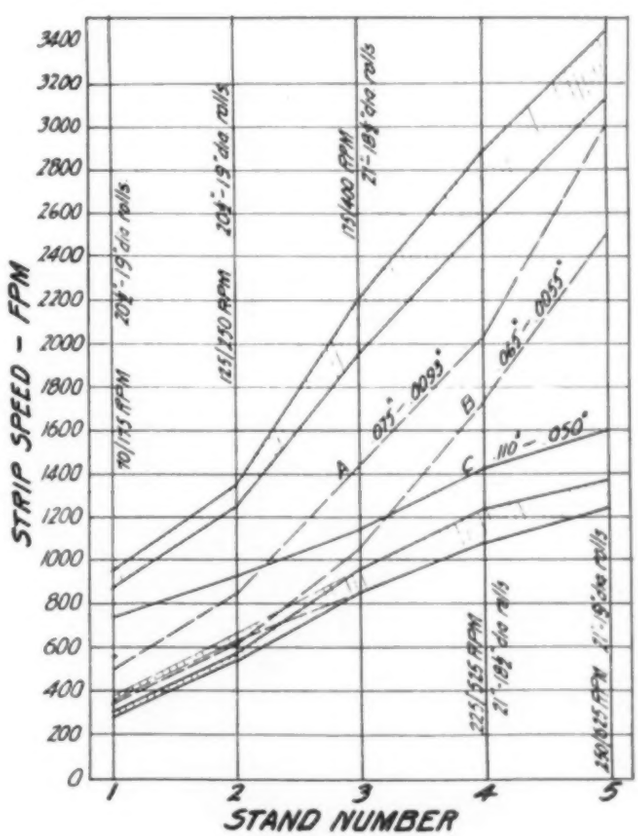
The machine ratings and a general description of the mill have been given in the previous paper by Mr. M. A. Leishman, and this data will not be repeated here. It is the intention of this paper, rather, to describe the main drive electrical system with special reference to those features which are novel to the design and have not been discussed before the Association of Iron and Steel Engineers in papers on other tandem mills.

SEPARATE GENERATOR SYSTEM

The mill uses the separate generator system which was selected largely because it made IR drop boosters unnecessary, reduced the number of rotating machines, simplified the heavy copper connections and buswork, and reduced the total space required in spite of the greater length of the main motor generator sets themselves. The use of separate generators also reduced the magnitude of fault currents that could be experienced, simplifying the problem of supporting the buses and making smaller, cheaper circuit breakers suitable.

Some advantage was also taken of the greater flexibility of the separate generator system to lower the bottom of the speed cone on stands 1 and 2 to accommodate some of the lighter tinplate gages such as that for 0.0055 in. finished strip as plotted in Figure 1. This speed cone shows the speed selected for each of the five mill stands to meet the wide range which the mill was intended to roll; finished product runs from the lightest tinplate gages to sheet 0.050 in. thick, and it is expected that even heavier gages will be rolled. The crosshatched areas of the speed cone indicate the speeds which are of doubtful availability because of variations in roll size. The area between the upper and lower crosshatched areas indicates the speeds available by adjustment of the stand speed rheostats. The lower crosshatched area appears twice for stands 1 and 2, the upper branch giving the speed cone, if only that range of speed available through motor field control were used, and the lower branch defining the actual

Figure 1 — Speed cone for 5-stand tandem cold reduction mill.



speed cone used by incorporating some control of generator voltage into the stand 1 and 2 speed rheostats. This spreading of the speed cone by motor armature voltage control effected considerable economy in the purchase of motors for these stands while limiting the torque capacity not at all at speeds above base, and reducing it a maximum of 20 and 15 per cent at minimum speeds below base.

MAIN CIRCUITS

The main circuits are illustrated in Figure 2. Each stand motor is connected by copper bus in a series circuit with its own individual generator; circuit breakers with overload trip coils are included in each positive bus, and contactors in each negative bus. Dynamic braking circuits are provided to stop each mill stand in the event the stand circuit breaker opens. Stands 1, 2, and 3 have single armature motors; stands 4 and 5 double armature motors with the armatures connected in parallel; and the reel a double armature motor with the armatures connected in series. The generators for stands, 1, 2, and 3 together with the reference exciter, are assembled into a motor generator set driven by a 7500 hp synchronous motor; the generators for stands 4 and 5 and the reel, together with a constant potential exciter, are assembled into a second motor generator set driven by a duplicate synchronous motor.

CONTROL SYSTEM

The control for each stand is built around an accurate fast response speed regulating system which matches each stand speed to a pattern or reference voltage which is common to all stands. Hence all stand speeds are accurately matched to each other.

MASTER CONTROL

A variable voltage d-c "reference exciter" RE of Figure 4 is the source of pattern voltage which serves all stands by "reference bus" PR-NR. The voltage of this exciter is varied from zero to 250 volts to control the mill speed over a range from zero speed to maximum speed, the rate at which the exciter voltage is changed determining the rate at which the mill accelerates or decelerates.

The voltage of reference exciter RE is accurately controlled by a voltage rotating regulator R1 whose pattern field F1F2 is under control of a motor operated rheostat RH driven by motor RM. The rheostat operating through its full range adjusts the pattern field current from zero amperes to a maximum value to control the reference exciter voltage over its full range from zero to 250 volts. Since rotating regulator R1 has a self-energizing field S1S2 in a tuned armature circuit, the rotating regulator will always maintain the reference exciter voltage so that the rotating regulator differential voltage field F3F4, connected across the exciter terminals, will exactly cancel the pattern field F1F2. Hence rotating regulator R1 will regulate reference bus voltage to accurately match the pattern field current.

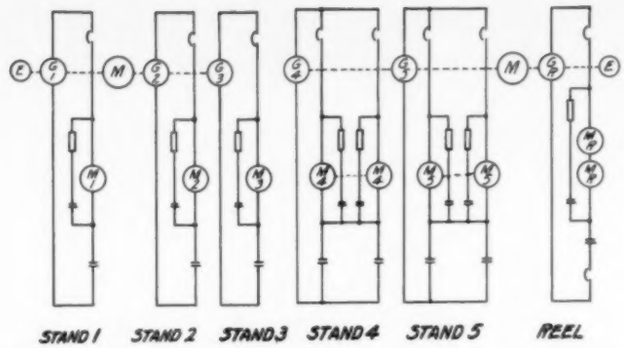
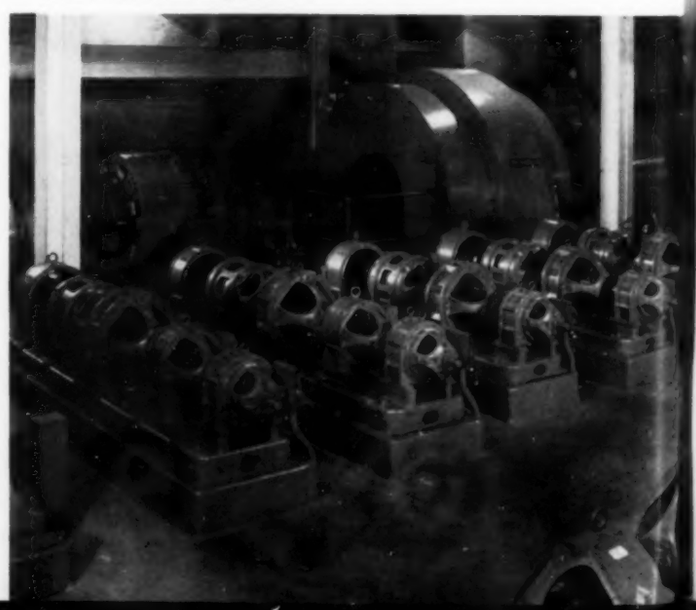


Figure 2 — Diagram of main circuits of mill drive. Separate adjustable voltage systems are used for each stand and for the reel.

Rheostat RH which controls the pattern field is driven by a shunt wound direct current motor RM whose source of armature voltage is generator RG which is a part of the constant speed master exciter set. The speed of operation of the rheostat and hence the rate of change of pattern current, reference bus voltage and mill speed may be varied by varying the voltage output of generator RG. Two rheostats in the generator field circuit are mounted on the master control switchboard. One is located in a circuit completed by contactor R and permits adjustment of the accelerating time of the mill from six seconds to considerably more than one-half minute from rest to top speed. The other is located in a circuit completed by contactor 1 to permit adjustment of the decelerating time over the same range. It will be noted that accelerating contactor R energizes the rheostat generator field in a direction to result in rheostat RH moving in a direction to raise mill speed, while L energizes the field with reverse polarity to bring about an opposite rotation of the rheostat to lower mill speed. The mill operator has full control of the rheostat operation and hence of mill speed through Thread, Fast, Stop and Hold pushbutton stations located on the mill control cabinets.

The main circuits, field and principal control circuits for one of the five stands are shown in Figure 5.

Figure 3 — Five of the seven rotating regulator exciter sets with a portion of one of the two main motor generator sets in the background.



STAND CONTROL

Mill motor M has its field MF1-MF2 separately excited by its own exciter E4 whose field F1F2 is excited from a constant potential d-c source under control of circuit D of the motor operated stand speed rheostat. The stand speed rheostat is preset by the roller before starting a schedule, to give the correct maximum stand speed for that schedule as determined from his rolling data. The motor operated rheostat is located in the basement and is set by the roller, using a control switch on the stand cabinet and observing a preset speed indicating instrument which indicates rheostat position but is actually calibrated in feet per minute. The motor

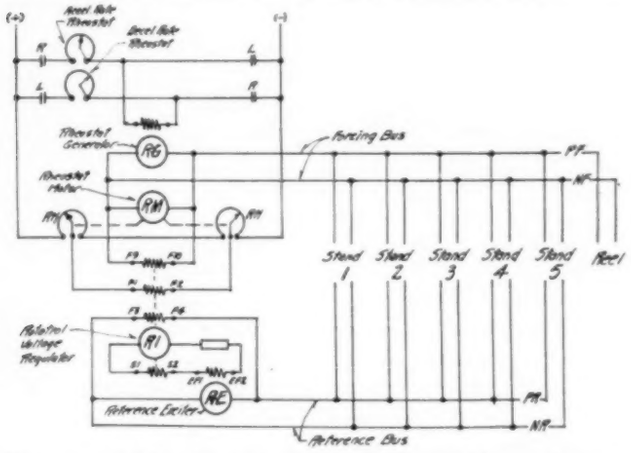


Figure 4 — Simple master control provides reference source for matching stand speeds, adjustable rates of acceleration and deceleration, and forcing to maintain speed coincidence.

field, having been thus set, remains constant until a change in the product being rolled requires a new set-up of the mill.

Stand generator G obtains its field excitation from an exciter E5 which is under control of a speed regulating rotating regulator R. Rotating regulator R has a principal control field F1F2 which is connected in a speed regulating circuit to measure the difference in voltage between a portion of reference bus PR-NR voltage, as determined by the position of potentiometer C, and speed pilot generator PG voltage.

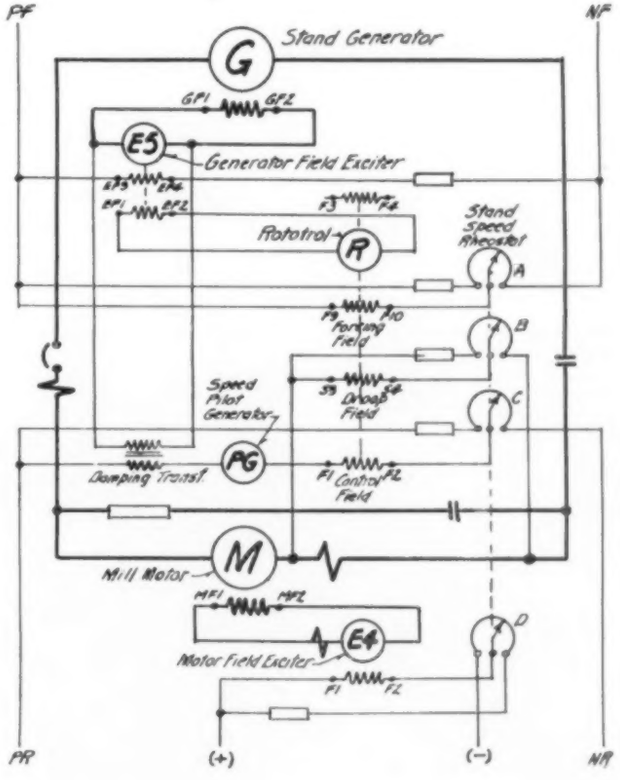
Potentiometer circuit C of the stand speed rheostat is the circuit which sets the stand speed relative to other stands, and it has a range of adjustment equal to the rated speed range of the particular stand motor, plus, in the case of stands 1 and 2, some additional range corresponding to some reduction in speed below motor base speed. It sets the proportion of the reference bus voltage which is to be used as a regulator pattern voltage to determine stand speed. Speed pilot generator PG is a shunt wound direct current generator which is located on a bracket on the commutator end bearing pedestal of the mill motor (Figure 6) and is geared to the motor shaft through a precision gear unit which steps up the motor shaft speed to a suitable speed for the pilot generator. Since the speed pilot generator shunt field current is of fixed value, the armature output voltage gives an accurate indication of motor speed. This voltage is opposed to the selected pattern voltage so that any difference or error voltage above or below that necessary to furnish the required steady state rotating regulator excitation forces more or less current through the rotating regulator F1F2 field to bring about a change in rotating regulator output voltage, generator field exciter output voltage, and generator output voltage to bring about a speed change in mill motor M. The system stabilizes when the mill motor has reached such a speed that speed pilot generator PG output voltage exactly matches the pattern voltage except for the small difference required to supply the necessary rotating regulator steady state field ampere turns.

Since this regulating system has a very high amplification and fast response, the motor speed follows changes in PR-NR reference bus voltage very closely and good accuracy is obtained even during fast accelerating and decelerating operations. However, since the system has such high amplification, auxiliary means are required to give dead beat regulation and eliminate overshoot or hunting. A damping transformer has therefore been used to feed back a voltage proportional to rate of change of generator exciter E5 voltage into the rotating regulator F1F2 field circuit in a manner to stabilize the system.

INTRODUCTION OF SPEED DROOP

If field F1F2 were the only field winding on the speed regulating rotating regulator, the speed of the mill stand would remain constant regardless of the load on the mill motor and the speed-torque characteristic curve would be a straight horizontal line as indicated by

Figure 5 — Rotating regulator speed regulating system gives fast accurate control of stand speed.



the horizontal 100 per cent speed line on the lower graph of Figure 7. This would result in a stiff mill which would be difficult, if not impossible, to operate, and some droop must be added to the characteristic to soften the mill and make it operable. This is done by adding field S3S4 to the rotating regulator and energizing it from the drop in voltage across the motor interpole and compensating field windings so that the current in it is directly proportional to the motor armature current or load. By adjusting the strength of field S3S4, any desired speed droop may be obtained; the lower graph of Figure 7 shows a speed droop of 5 per cent at 100 per cent load and it should be noted that the speed-torque curve is a perfectly straight line with the amount of droop directly proportional to motor load. Potentiometer circuit B adjusts this field circuit so that the percentage speed droop will be the same for any motor speed over its rated range from base to top speed as set by the stand speed rheostat.

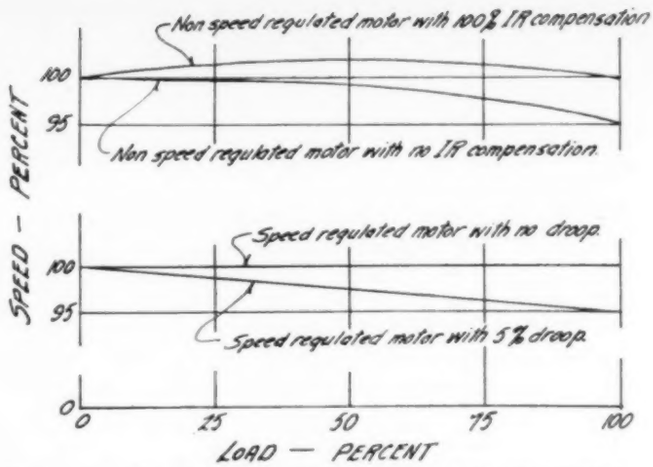


Figure 7 — Speed-torque curve of typical direct current motor (top) and of speed regulated motor (bottom) demonstrates perfect straight line characteristic of regulated drive.

HISTORY OF IR DROP COMPENSATION

At this point we should review the earlier methods of control to see why the speed regulator described above is different to anything we have used in tandem mills heretofore and why we feel that it has merit.

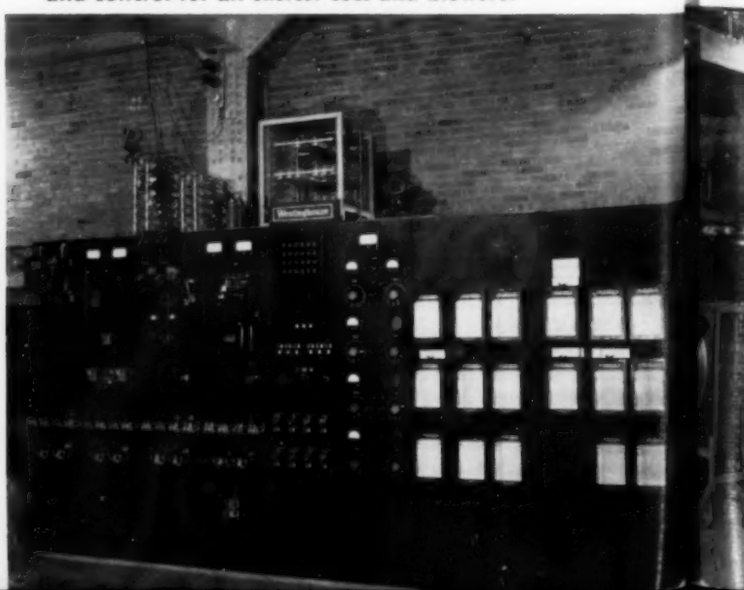
The early mills used a variable voltage drive with a common d-c bus serving all mill motors. While this was fairly satisfactory for the first slow speed mills in which the ratio of running to threading speed was comparatively low, it was soon realized that IR drop compensation, as it was called, would be most desirable in order to maintain better speed co-ordination between stands over the whole speed range, would give much better performance of the mill at threading speeds, would prevent stalling of heavily loaded stands at threading speeds and could with proper adjustment contribute toward the reduction of off-gage strip during the accelerating and decelerating periods.

As mill speeds increased these considerations became more important and IR drop compensation in one form or another became a part of all new tandem mill control systems. However, in spite of its theoretical advantages, and in spite of a number of very successful applications, the history of IR drop compensation has not been one of 100 per cent successes, and little use is made of the future on some mills where it is available, while it is cut out entirely on others.

In some cases at least, it is very probable that this is because the motor speed torque characteristic as modified by IR drop compensation has at some point resulted in an increase in speed with increase in load; a condition which produces instability. The upper graph of Figure 7 shows a motor speed-torque curve which has 5 per cent droop at full load. Unlike the speed-torque curve obtained with the speed regulator, that of a d-c motor is seldom a perfectly straight line, and may curve down or up, or both down and up, at different loads. The typical curve shown is not a straight line and if IR drop compensation is used, the curve rises from zero to about one-half load resulting in an unstable condition for operation within this range. This curve is not necessarily typical of the large motors built for tandem mills today, most of these motors having much better characteristics than that illustrated as the result of careful design and good test procedures. How-

Figure 6 — 1500 hp, stand No. 1 mill motor with rugged speed pilot generator and tachometer driven through a planetary gear unit from the motor shaft.

Figure 8 — Master switchboard provides annunciation, graphic instrumentation, control of the constant potential and reference exciters, taper tension control and control for all exciter sets and blowers.



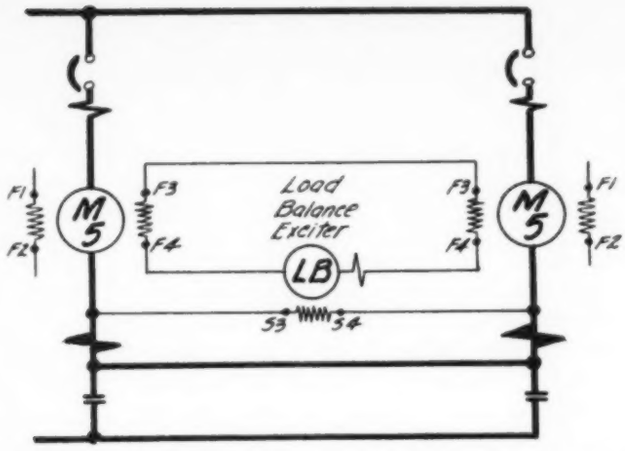


Figure 9 — A load balance rotating regulator exciter forces the two armatures of the double armature motors on stands 4 and 5 to share the load equally.

ever, the curve is not unusual for older motors or for smaller motors.

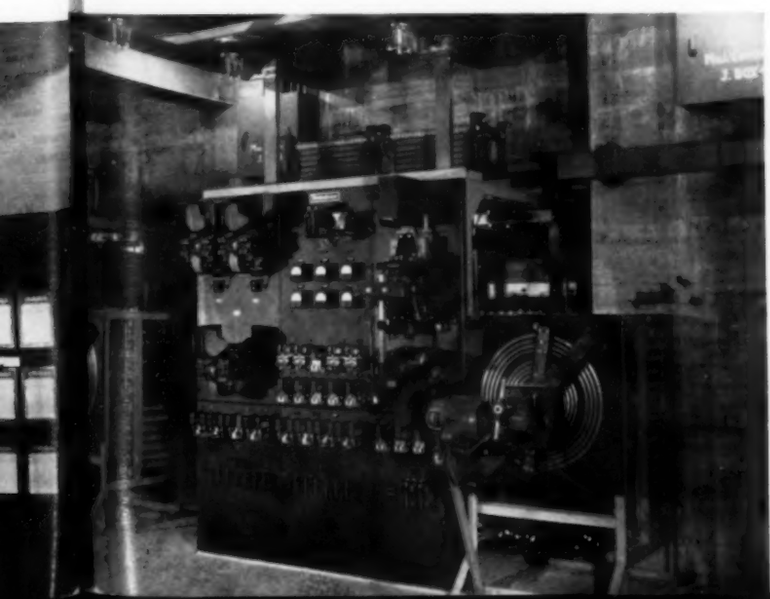
Again in some cases it may be that the mill motor had a characteristic which was so nearly flat at some speed setting that the addition of any IR drop compensation resulted in such a flat characteristic that the mill became too stiff and could not be operated under this condition.

The ideal motor speed-torque curve, if IR drop compensation is to be used, is one in which the per cent droop at full load is equal to or slightly greater than the per cent IR drop at full load, and the curve is a straight line from zero to 200 per cent full load. Motors with such desirable characteristics can be built, but they do require special attention to the design and they do require that special attention be given the motors on test. Any control scheme that would produce the desired performance whether or not the motors had the most suitable characteristics would be a most desirable development.

On the earlier common bus drives, the IR drop compensation was added by IR drop boosters between the common d-c bus and individual motors. On the more recent separate generator drives, the generator voltages have been regulated to give the equivalent of a common bus, but the IR drop compensation has been introduced into the main generators also. In either case the performance of the system is the same and is intimately related to the mill motor characteristics as described above.

Therein lies the chief difference between previous drives and that used in the Steel Company of Canada mill. The speed-torque curve of each stand drive on this mill is quite independent of the mill motor characteristic and is dependent on the speed regulator characteristic only. The motors therefore need be only good stable mill motors, they need no special attention. Any speed-torque characteristics desired may be introduced into the regulator, it may be altered quickly and easily, and as it is always straight line it can never, even with 100 per cent compensation, take a dangerous unstable rising form.

Figure 10 — Six switchboards, such as that illustrated for one stand, provide controls for the individual stands and the reel.



LOAD BALANCE CONTROL

Special measures have to be taken to ensure that both armatures of the double armature motors of stand 4 or stand 5 share their loads equally. Special crossed series fields or load balance exciters have been used in the past to accomplish this. In this mill a load balance rotating regulator with a single control field has been used, the schematic diagram being shown in Figure 9. The rotating regulator LB excites an auxiliary load balance field on each of the twin mill motors, the two fields being connected differentially in series. The control field is connected from a point on the positive side of the interpole compensating field winding of one motor to a corresponding point on the other motor. As long as the motor loads are balanced, no current flows in the rotating regulator field, because the drops in voltage through the interpole compensating field windings of each of the two motors to the common negative are the same. However, any tendency of one motor to carry more than its share of the load results in an unbalance of the interpole compensating field winding voltage drops, which in turn results in a flow of current through rotating regulator field S3S4. The rotating regulator builds up voltage which circulates current through the motor load balance fields in a direction to strengthen the field of the more heavily loaded motor, and to weaken the field in the more lightly loaded motor, thus restoring the load balance.

EMERGENCY STOP

An emergency stop which is as fast as can be safely completed by the mill motors is required in order to reduce the seriousness of a strip break to a minimum, keeping the amount of lost strip as low as possible and minimizing the possibility of pinching of the work rolls or backup rolls as the result of a cobble.

A 3½ to 4 second emergency stop, the minimum to which the mill motors should be subjected, is achieved on this mill by using regenerative braking resulting from a fast speed controlled stop. The stop is identical with a normal deceleration or stop, using the master and stand speed regulator control already described, except that rheostat motor RM is driven at a fast rate

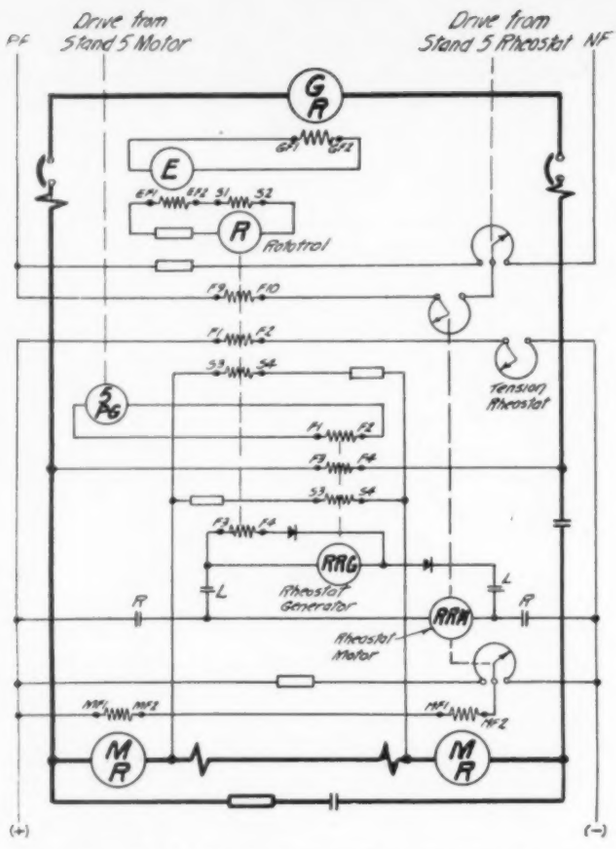


Figure 11 — Reel drive makes use of current rotating regulator for generator field and rotating rheostatic regulator for motor field.

by connecting it along with forcing bus PF-NF, to a 250 volt d-c constant voltage source instead of to rheostat generator RG. This not only gives a fast stop, but eliminates the initial time delay that would otherwise result while RG generator voltage was building up.

REEL CONTROL

The 20-in. diameter collapsible mandrel type reel is driven by a double armature motor obtaining its power from its own d-c generator. Reel tension control is by rotating regulator current regulator operating on the generator field to maintain constant load current. The range of motor speed to take care of coil buildup is then obtained by a rotating regulator rheostatic type of counter emf regulator which controls the field of the double armature reel motor. Forcing is provided from the PF-NF forcing bus during acceleration and deceleration to maintain approximately constant tension between stand 5 and the reel. This forcing is modified by a circuit on the reel motor field rheostat so that it will be approximately the correct value for any diameter of coil. Circuits for the reel are shown in Figure 11.

OPERATING EXPERIENCE AND ADJUSTMENT

It is well known that the gage of the strip delivered from a cold mill is a function of the speed of rolling and that the gage tends to increase as the speed decreases. A method of using an IR drop compensation adjustment which would permit tension to build up between stands as speed decreased and so tend to hold gage, was described by G. E. Stoltz in a paper, "Report of Field Tests on IR Drop Compensation," AISE Yearly Proceedings, 1942, pp 281-289. It was our intention to adjust the droop to accomplish the same thing and we finally arrived at a setting that seemed ideal for all the tinplate schedules. The droops were of the order of 1 per cent of top speed on stand 1, with 1½, 2, 2½, and 3 per cent respectively on stands 2, 3, 4 and 5. With tinplate gages, these settings resulted in about the maximum permissible tension buildup in the steel between stands as the mill was slowed to thread speed and so gave us the best gage control that could be expected.

However, the tendency for gage to change with change in speed of rolling is very pronounced in the 4th and 5th stands with the tinplate gages under 0.015 in. thick, but is much less noticeable with the thicker gages. As a consequence, the droop settings which gave such good operation with tinplate, resulted in a hopelessly soft mill with heavy sheet. At thread speed, tension would fall off to zero between stands and loops would even form between stands.

A taper tension control has been provided on the mill to automatically readjust the relative stand speeds with change in mill speed and this was employed, with sheet schedules only, to correct this condition. While it worked out very well, it was finally decided that the better way to approach the problem, would be to readjust the droops to the best values for the schedule being rolled.

Consequently rheostats in the rotating regulator droop field circuits have been located on the operators control cabinets and are reset when changing from tinplate to sheet gages. The droops that give good performance on the heavy sheet gages from 0.023 to 0.050 in. thick have been found to be about 3 per cent of top speed on stand 1 with decreasing values through the mill to 1½ per cent on stand 5.

These measures have finally given us excellent operation on all schedules, on a mill which has to roll an unusually varied product.

DISCUSSION

PRESENTED BY

C. B. HUSTON, Commercial Engineer, Industrial Engineering Dept., General Electric Co., Schenectady, N. Y.

RALPH A. HARVIE, Application Engineer, Canadian Westinghouse Co., Ltd., Hamilton, Ontario

C. B. Huston: It is implied from Mr. Harvie's paper that the IR drop compensation control has been wrong. If this is so, there are a lot of mills with "wrong" type of control rolling a lot of the "right" kind of steel.

I believe, instead, that the trouble, where it has existed, is due to the way that IR drop compensation has been applied. My company has always regulated the IR drop to match the load current on the motor. This has been true either with individual generator control or with separate IR boosters.

Figure 12 shows the voltage regulating circuit for individual generator control where IR drop compensation has been incorporated. The pilot generator, the master potentiometer rheostat and the generator exciter are common to all generators. The rotating regulators through which voltage regulation is obtained are in each case connected into the circuit as cemf machines and therefore operate at a low value on either side of zero voltage. This is one reason that the regulating system is extremely fast.

The IR drop compensation is obtained by introducing into the regulating loop a voltage which is produced by a small rotating regulator. This rotating regulator responds almost instantaneously with the change in load current. The voltage of the IR drop machine is, therefore, regulated to match the change in

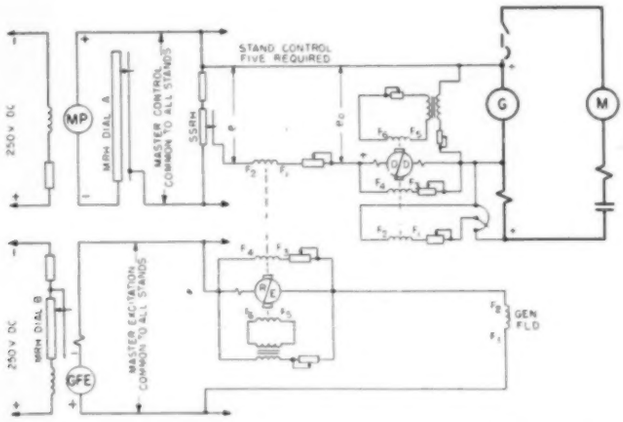


Figure 12 — Master control and voltage regulating system of one stand of a 5-stand tandem tin plate mill using an individual generator for each stand.

load current, and can readily be adjusted to a high or low value.

In order to properly use the IR drop control, it is important that the adjustments of same be made convenient to the operators at the mill. They will find that different values will be needed on different stands as well as the adjustments changed for the rolling of different schedules. Therefore, hand adjustment of IR drop compensation must be made readily available to the mill operators.

Coincident with the IR drop control, the proper characteristics of each motor is an important factor to the success of the system. Our machine designers have compensated the motors for all regulations except IR drop. This means that the motors have approximately the same speed regulation throughout the speed range, by field control. It is for this reason that IR drop compensation can successfully be applied.

Figure 13 shows starting the mill from rest and then accelerating it from threading to 4375 fpm in 9 seconds. Figure 14 shows decelerating the mill from 4500 fpm to threading speed in 6½ seconds. Figure 15 shows stopping the mill in an emergency when a strip broke

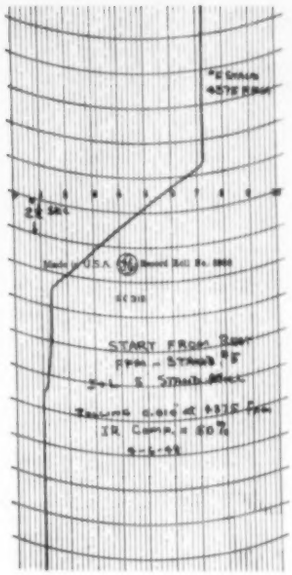


Figure 13 — When rolling 0.010 in. at 4375 fpm, this 5-stand tandem mill took 9 sec to get up to speed.

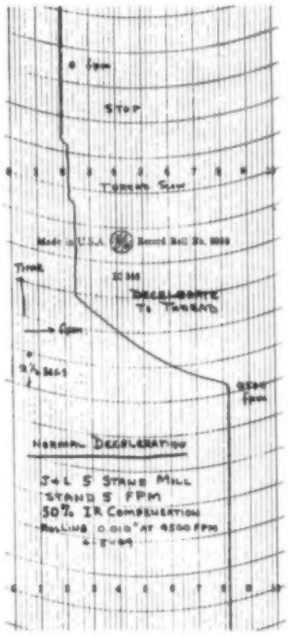


Figure 14 — It took 6½ sec to drop the mill speed from 4500 fpm to threading speed while rolling 0.010 in.

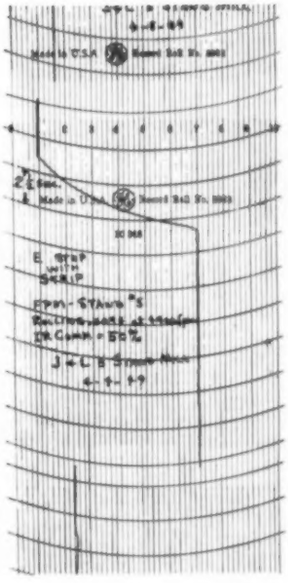


Figure 15 — The graphic record of an emergency stop is given in this figure.

between stands 4 and 5. Current limit pumpback on stand 5 controls the time of stopping. This time is less than 5 seconds.

It is interesting to note that current control has been used for tension on the winding reel. Our company has always been partial to this scheme over the use of mechanical tensiometers, and our scheme employs only one regulator. There is no separate mechanical device such as the motor operated rheostat which must follow the buildup of each and every coil.

A great deal of experimenting has been going on this past year on the balancing of load between top and bottom rolls of a twin drive. At the beginning, the operators were not sure what they wanted. Most people have thought that the tie should be made very rigid. The control can be very effective in this respect when needed. However, experience has dictated that a close hitch is not needed and at present the twin drives are working with not too rigid a tie.

It will be interesting to cite a few observations recently taken on the Jones & Laughlin Aliquippa works five-stand mill, rolling principally tinplate product.

1. Rolling 4400-4600 fpm.
   Some rollers run welds at top speed, others slow down to threading speed for the weld to go through.
2. Average time of roll change is 7 to 8 minutes.
   Maximum—10 min.
   Minimum— 5 min.
3. March 1949—38,512 tons for 75 turns.
   513 tons per turn.
   Minimum daily (3 turns)—1290 tons.
   Maximum daily (3 turns)—1851 tons.
4. IR compensation for various stands set as follows:

Stand No. 1	No. 2	No. 3	No. 4	No. 5
0 %	7½%	15%	30%	52½%

5. Acceleration of mill—9 sec, 200 fpm to 4400 fpm.
   Deceleration of mill—6½ sec, 4400 fpm to 425 fpm.
6. The strip usually comes on gage at 2500 fpm when rolling at 4400 fpm.
   The strip holds on gage down to threading speed.
7. The elapsed time from top speed of one coil to top speed of next coil is on the average 47 sec.
8. Screws are run up on stands 4 and 5 if mill is to be stopped for any appreciable length of time. Stand 5 bearings will freeze if full screw pressure is maintained indefinitely with mill at standstill. No. 1 and No. 2 stands give no trouble in this respect. The rollers make it a practice to raise the rolls on stands 4 and 5 in order to avoid flattening the backup rolls.

There is a demand for copies of the following Yearly Proceedings:

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ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

1950 Annual Convention

and

Iron and Steel Exposition

ASSOCIATION OF IRON AND STEEL ENGINEERS

CLEVELAND PUBLIC AUDITORIUM,

CLEVELAND, OHIO

SEPTEMBER 26, 27, 28 and 29

To the Men of the Steel Industry . . .

The steel industry is embarked on a large program of expansion and modernization which must be completed in record time. An unparalleled opportunity for steel plant personnel to get information on the latest developments that will lead to greater efficiency and greater production is provided in the 1950 Convention and Exposition of the Association of Iron and Steel Engineers.

I would like to emphasize that the IRON AND STEEL EXPOSITION is presented *for*, and not by, the producers of iron and steel. Also, I want to stress the fact that steel men are welcome to attend the Exposition and the technical sessions of the Convention, regardless of whether or not they are AISE members—and there is no registration fee.

I believe we have something for the steel man and his industry. I hope that you will be there.

A. S. GLOSSBRENNER,
President, AISE.

Preview . . . IRON AND STEEL EXPOSITION AISE ANNUAL CONVENTION

▲ A preview of plans for the 1950 Iron and Steel Exposition, to be held in Cleveland Public Auditorium, September 26, 27, 28, 29, indicates that the displays this year will turn up more new ideas for the iron and steel industry than in any other year. Presenting a theme of "Engineered Efficiency in Steel Plant Improvement," this biennial Exposition will, according to early information from the more than 150 exhibitors, bring some entirely new developments in products and processes to the attention of steel producers.

In general, working models and actual production units will be used to a much greater extent than in any previous exposition. One exhibit will show for the first time a new invention that will be of inestimable value in the finishing of strip steel and tinplate, as well as in any industry employing belt conveyors or dealing with continuous strands of flat material.

Rolling mill equipment will come in for its share of attention through exhibits ranging from working models of an electric-weld tube mill and a high speed cold mill to actual small production units.

In one exhibit, the visitors will be given a chance to try their hands at cable splicing. In another, industrial television will be in actual operation from cameras located in various parts of the exposition. The possibilities of television in production operations will also be discussed in a paper at one of the technical sessions of the meeting.

The AISE technical program, also held in the Cleveland Public Auditorium in conjunction with the Exposition, will include 46 technical papers, arranged in 14 separate sessions, dealing with specific problems of steel plant engineering, operating and maintenance. A highlight of the program is a general session scheduled for the afternoon of September 28, when H. B. Jordan, president of American Steel and Wire Co. will present the main address. Speaking also at this session will be T. D. Jolly, vice president of the Aluminum Co. of America, who will speak on "Engineering and Purchases" and Clifford Strike, president of F. H. McGraw Co., who will discuss the "Proposed New England Steel Plant."

Another feature of the meeting will be an inspection trip to the Lorain plant of National Tube Co., where new bessemer, rolling mill and seamless tube mill facilities have been recently put into operation. This plant is also featured in a comprehensive story to be published in the September issue of the Iron and Steel Engineer and distributed in reprint form on the inspection trip.

Tickets for the Exposition will be widely distributed throughout the iron and steel industry, and are also available upon request to AISE headquarters, 1010 Empire Building, Pittsburgh, Pa.

Among the many working models to be shown at the Iron and Steel Exposition will be a model of Youngstown Sheet and Tube Co.'s 26-in. electric weld tube mill. This will be the first showing of this model to the steel industry.

Technical meetings, which will also be held in the Cleveland Public Auditorium, include 46 papers arranged in 14 separate sessions.

The steel men who attend the Iron and Steel Exposition cannot fail to take home several ideas that should help their companies make steel more efficiently.

The inspection trip to the Lorain Works of the National Tube Co. will be held on Wednesday, September 27.

A highlight of the convention will be the annual banquet in the Hotel Statler on Thursday, September 28.

The 1950 Iron and Steel Exposition will occupy the Arena and Exhibit Halls of the Cleveland Public Auditorium. This will be the largest exposition ever held by the AISE.

Program

1950 AISE CONVENTION and IRON AND STEEL EXPOSITION

CLEVELAND, OHIO

Tuesday, September 26

9:00 am—REGISTRATION—Main Lobby

9:00 am—LADIES REGISTRATION AND HEADQUARTERS—Hotel Statler

9:15 am—BUSINESS MEETING—Ball Room
Conducted by President A. S. Glossbrenner

9:30 am—COMBUSTION SESSION—Club Room B

Chairmen: Edwin C. McDonald, Combustion Engineer, Republic Steel Corp., Corrigan McKinney Works, Cleveland, Ohio.

C. E. Duffy, Fuel Engineer, Bethlehem Steel Co., Sparrows Point, Maryland.

"The Use of the Jet Mill for Combustion Purposes and for the Fine Grinding of Various Materials," by G. M. Croft, Manager, Fuel Equipment Department, Blaw-Knox Co., Pittsburgh, Pa.

"Dust, Fume and Smoke Suppression," by Aubrey J. Grindle, Vice President and Consulting Engineer, Whiting Corp., Harvey, Ill.

"Reduction of Hanging and Slipping in Blast Furnaces by Automatic Control," by Otto J. Leone, Engineer, West Newton, Pa.

9:30 am—ELECTRICAL SESSION—Ball Room

Chairmen: J. H. Franz, Superintendent Fabricating Shops, Carnegie-Illinois Steel Corp., McDonald Works, Youngstown, Ohio.

R. J. Beeswy, Assistant Superintendent, Electric Power and Steam Department, Inland Steel Co., East Chicago, Ind.

"Electroplating Rectifiers," by L. W. Reinken, Chief Engineer, W. Green Electric Co., New York, N. Y.

"Preventive Maintenance of Electric Overhead Cranes," by H. C. Mullings, Assistant Superintendent Maintenance, Electric Division, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

"Low Inertia D-C Motors for Rolling Mill Drives," by J. Henry Schneider, Section Engineer, D-C Machines, Elliott Co., Ridgway, Pa.

12:00 noon—LADIES LUNCHEON
(Meet at Ladies Headquarters)

2:00 pm—STANDARDIZATION SESSION—Ball Room

Chairmen: L. J. Gould, Chief Engineer of Construction, Bethlehem Steel Co., Bethlehem, Pa.

Eric Anderson, Electrical Superintendent, Bethlehem Steel Co., Johnstown, Pa.

"Standardization Report," by L. J. Gould, Chairman, AISE Standardization Committee.

"Report on Mill Motor Standardization," by M. B. Antrim, Chairman, AISE Mill Motor Committee.

"Progress Report of Carbon Brush Standardization," by E. L. Anderson, Chairman, AISE Carbon Brush Standardization Committee.

"Recommended Plain Bearing Design Practice," by C. E. Pritchard, Chairman, AISE Plain Bearing Committee.

"Progress Report on Wiring Standardization," by J. E. Bodoh and C. G. Dimitt, Co-chairmen, AISE Wiring Committee.

"A Proposed Specification for Hot Metal Ladles," by B. G. Johnston, Fritz Engineering Laboratory, Lehigh University, Bethlehem, Pa.

2:00 pm—MECHANICAL SESSION—Club Room B

Chairmen: J. J. Healy, Project Engineer, Armco Steel Corp., Middletown, Ohio.

P. L. Walter, Superintendent Mechanical Department, Republic Steel Corp., Canton, Ohio.

"Rolls for Centering and Alining Materials," by E. T. Lorig, Chief-Senior Staff Engineering Bureau, Carnegie-Illinois Steel Corp., Pittsburgh, Pa.

"New Facilities for the Stocking and Shipping of Pipe at Lorain Works of National Tube Company," by C. Clarke Wales, Chief Project Engineer, National Tube Co., Lorain, Ohio.

"Some Aspects of Selecting and Applying Gears for Rolling Mill Equipment," by Edward C. Denne, Consultant and Manager of Gear Dept., United Engineering and Foundry Co., Pittsburgh, Pa.

10:00 pm—EXHIBITORS DANCE—Euclid Ball Room, Hotel Statler

Wednesday, September 27

9:00 am—ROLLING MILL SESSION—Club Room B

Chairmen: D. W. Lloyd, General Superintendent, Youngstown Sheet and Tube Co., Youngstown, Ohio.

C. P. Hammond, Superintendent Rolling Mills, Rotary Electric Steel Co., Detroit, Mich.

"The Design and Use of Tungsten Carbide Rolls for Cold Rolling Metals," by R. T. Beeghly, Vice President and General Manager, Metal Carbides Corp., Youngstown, Ohio.

"The Continuous Seamless Pipe Mill," by John L. Young, Vice President-Engineering, National Tube Co., Pittsburgh, Pa.

"Rolling of Tool Steels," by H. C. Bigge, Superintendent of Tool Steel Div., Bethlehem Steel Co., Bethlehem, Pa.

9:00 am—ELECTRICAL SESSION—Ball Room

Chairmen: K. L. Johannsen, Superintendent, Assigned and Operating Maintenance, Carnegie-Illinois Steel Corp., Duquesne, Pa.

R. W. Graham, Superintendent Electrical Department, Bethlehem Steel Co., Lackawanna, N. Y.

"Transformer Oils in the Steel Plant," by John F. Boal, Lubrication Engineer, Carnegie-Illinois Steel Corp., Homestead, Pa.

"Requirements for a Modern Steel Mill Distribution System," by F. H. Wickline, Construction Electrical Engineer, National Tube Co., Lorain, Ohio.

"Grounding Practice of the Inland Steel Company," by V. E. Schlossberg, Superintendent Electric Power and Steam Departments, Inland Steel Co., East Chicago, Ind.

12:00 noon — LADIES LUNCHEON

1:00 pm—INSPECTION TRIP—National Tube Company, Lorain, Ohio

6:00 pm—OLD TIMERS DINNER

Thursday, September 28

9:00 am—TRAINING SESSION—Ball Room

Chairmen: I. N. Tull, Electrical Superintendent, Republic Steel Corp., Cleveland, Ohio.

John H. Vohr, General Superintendent, Carnegie-Illinois Steel Corp., Gary Works, Gary, Ind.

"Supervisory Development," by A. C. Croft, President, National Foremen's Institute, Inc., New London, Conn.

"The Bethlehem Loop Course," by H. C. Houghton, Assistant to Manager of Personnel, Bethlehem Steel Co., Bethlehem, Pa.

"Motor Inspection Training Programs," by George Kennedy, Carnegie-Illinois Steel Corp., Pittsburgh, Pa.

9:00 am—LUBRICATION SESSION—Club Room A

Chairmen: W. M. Schuck, Lubrication Engineer, Armco Steel Corp., Middletown, Ohio.

R. A. Kraus, General Mechanical Foreman, Republic Steel Corp., Chicago, Illinois.

"What to Look for in Hydraulic Fluids," by Anthony J. Zino, Jr., Assistant Sales Manager, Industrial Division, Swan-Finch Oil Corp., New York, N. Y.

"Rolling Solutions for Specialty Steels," by Maxwell L. Bible, General Foreman, Cold Reduction Div., Crucible Steel Company of America, Midland, Pa.

"Metal Drawing Lubricants for Wire, Tubing and Sheet Steel," by Walter A. Smigel, General Manager and H. Grey Verner, Ph. D., Director of Research, R. H. Miller Co., Inc., Homer, N. Y.

9:00 am—COMBUSTION SESSION—Club Room B

Chairmen: R. A. Lambert, Superintendent, Steam and Combustion, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

E. T. W. Bailey, Chief Combustion Engineer, Steel Company of Canada, Ltd., Hamilton, Ontario, Canada.

"The Public Demands Better Combustion," by L. T. White, Director, Business Research, Cities Service Oil Co., New York, N. Y.

"The Application of the Heat Prover to the Steel Industry," by Joe G. Sparks, Cities Service Oil Co., Chicago, Ill.

"Economics of a 500-Ton Open Hearth Furnace," by Walter W. Kompart, Combustion and Hydraulic Engineer, Weirton Steel Co., Weirton, W. Va.

"Oxygen for the Open Hearth—Its Storage and Distribution," by R. Tietig, Jr., Engineer and B. P. Sarasin, Engineer, A. J. Boynton & Co., Chicago, Ill.

2:00 pm—GENERAL SESSION—Ball Room

Chairmen: A. S. Glossbrenner, Vice-President Operations, Youngstown Sheet and Tube Co., Youngstown, Ohio.

An address by H. B. Jordan, President, American Steel and Wire Co., Cleveland, Ohio.

"Engineering and Purchases," by Thomas D. Jolly, Vice President—Engineering and Purchases, Aluminum Company of America, Pittsburgh, Pa.

"Proposed New England Steel Plant," by Clifford S. Strike, President, F. H. McGraw & Co., New York, N. Y.

7:00 pm—FORMAL DINNER AND DANCE—Grand Ball Room—Hotel Statler

Friday, September 29

9:00 am—OPERATING PRACTICE SESSION—Club Room B

Chairmen: W. H. Collison, Superintendent of Coke Plant, Great Lakes Steel Corp., Ecorse, Detroit, Mich.

Paul E. Thomas, Assistant General Superintendent, Carnegie-Illinois Steel Corp., Gary, Ind.

Density Control of Coal Charged in Coke Ovens," by C. W. Stahl, Engineer, Coal and Coke Chemical Research, Bethlehem Steel Co., Bethlehem, Pa. and J. K. Kurtz, Coke Oven Superintendent, Bethlehem Steel Co., Sparrows Point, Maryland.

"The Use of a Fuel Oil as an Absorption Oil in Recovery of Light Oil from Coke Oven Gas," by C. R. Montgomery, Chief Chemist, By-Product Coke Dept., Pittsburgh Steel Co., Pittsburgh, Pa.

"Blast Furnace Hearth Cooling," by Owen R. Rice, Freyn Engineering Co., Chicago, Ill.

9:00 am—ELECTRICAL SESSION—Ball Room

Chairmen: W. J. Tunny, Superintendent Electrical Maintenance, Youngstown Sheet and Tube Co., East Chicago, Ind.

Malcomb B. Antrim, Superintendent, Electrical Maintenance, Lukens Steel Co., Coatesville, Pa.

"Temper Rolling with Modern Control," by J. F. Sellers, Engineer-in-Charge D-C Design, R. M. Peeples, Engineer and A. C. Halter, Engineer, Control Section, Engineering Department, Allis-Chalmers Manufacturing Co., Milwaukee, Wisconsin.

"Temper Mill Power Requirements," by Wm. P. Smith, Industrial Engineering Divisions, General Electric Co., Schenectady, N. Y., and J. E. Butler, Electrical Engineer, Weirton Steel Co., Weirton, W. Va.

"Acceleration Characteristics of Tandem Cold Reduction Mills, by W. R. Harris, Manager, Metal Working Section, Industry Engineering Department and R. W. Moore, Steel Mill Engineer, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

2:00 pm—LUBRICATION SESSION—Club Room B

Chairmen: D. E. Whitehead, General Lubrication Engineer, Crucible Steel Co. of America, Pittsburgh, Pa.

N. I. Whiteley, Lubrication Engineer, American Steel and Wire Co., Cleveland, Ohio.

"Graphite as a Lubricant," by E. S. Glauch, Mechanical Engineer, Joseph Dixon Crucible Co., Jersey City, N. J.

"Extreme Pressure Lubricants," by James H. Lewis, Lubrication Engineer, Carnegie-Illinois Steel Corp., Clairton, Pa.

"Laboratory Screening of Multi-Purpose Type Greases for Plant Performance Testing," by E. M. Kipp, Chief, and C. A. Zeiler, Research Engineer, Lubricants Division, Aluminum Research Laboratories, Aluminum Co. of America, New Kensington, Pa.

2:00 pm—OPERATING PRACTICE SESSION—Ball Room

Chairmen: G. C. Brainard, Jr., Assistant Superintendent Cold Strip Mill, Youngstown Sheet and Tube Co., Youngstown, Ohio.

P. E. Haglund, Superintendent, Raw Materials and Semi-Finished, Ford Motor Co., Dearborn, Mich.

"Analyzing Open Hearth Data—Statistics vs. Opinion," by Wade R. Weaver, Director, Steel Conservation and Quality Control, Republic Steel Corp., Cleveland, Ohio.

"Centerless Turning of Bars, Billets and Tubes," by Walter Siegerist, President, The Medart Co., St. Louis, Mo.

"Television in Industry," by J. A. Good, Manager, Electronics Department, Diamond Power Specialty Corp., Lancaster, Ohio.

EXPOSITION AND TECHNICAL SESSIONS are at Cleveland Public Auditorium.
SOCIAL FUNCTIONS are at Hotel Statler.

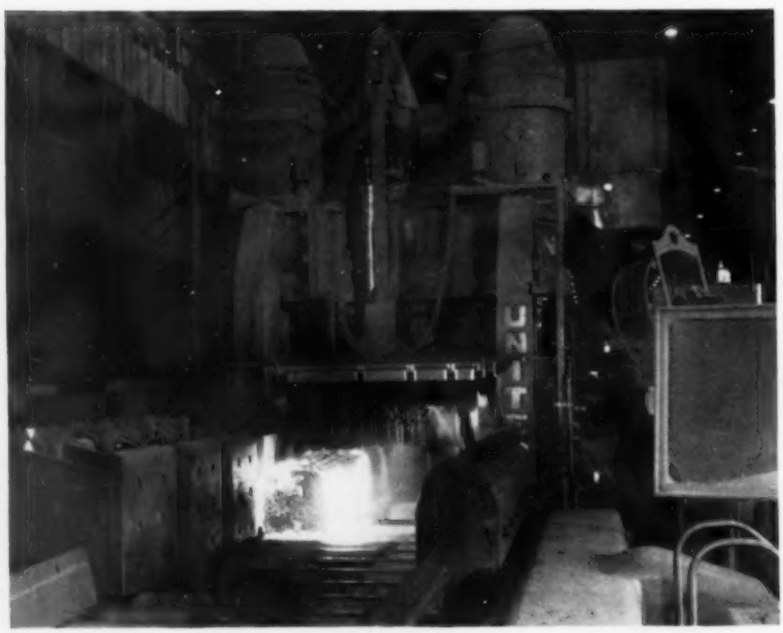
INSPECTION TRIP

to

NATIONAL TUBE COMPANY'S LORAIN WORKS

WEDNESDAY, SEPTEMBER 27

Busses will leave Cleveland Public Auditorium at 1:00 pm. Trip is limited to citizens of the United States and Canada. Other nationals must obtain their own clearances in the usual manner, which must be shown before ticket can be purchased. Bus tickets may be purchased at registration desk — Price $2.00.



This 46-in. blooming mill is just one unit in the huge expansion program at Lorain. This program included blooming and billet mill, seamless mill, complete new bessemer plant, warehouses, and various other facilities. Many unusual features are incorporated in the design of these units.

You can't afford to miss WHAT'S NEW IN 1950!

SEE IT AT THE
IRON and STEEL EXPOSITION
CLEVELAND
SEPTEMBER 26, 27, 28, 29

LIST OF EXHIBITORS

Air Reduction Sales Company—138, 139, 140.
Ajax Flexible Coupling Company, Inc.—102, 103.
Alemite Division, Stewart-Warner Corp.—115, 116.
Allen-Bradley Company—308, 309, 310.
Allis-Chalmers Manufacturing Company—35, 36, 37.
American Brake Shoe Company—211, 212, 228, 229.
American Bridge Company—62, 63.
American Machine and Metals, Inc., DeBothezat Fans Division—8, 9
American Steel and Wire Company—62, 63.
Ampco Metal, Inc.—40, 41.
Amsler Morton Corporation—42.
Appleton Electric Company—299, 300.
Askania Regulator Company—242, 243.
Automatic Transportation Company—38, 39, 66, 67.

Babcock and Wilcox Company—33, 34.
Bailey Meter Company—54, 55.
Baker Industrial Truck Division, Baker-Raulang Company—86, 87, 88, 122, 123, 124.
Bantam Bearings Division, Torrington Company—318.
Bearing Service Company—320, 321.
Biddle Company, James G.—208.
Blaw-Knox Company—276, 277.
Bliss Company, E. W.—64, 65.
Bloom Engineering Company, Inc.—331, 332.
Bowser, Inc.—334.
Brosius Company, Edgar E.—20, 21.

Cardox Corporation—6.
Carnegie-Illinois Steel Corporation—62, 63.
Chemsteel Construction Company, Inc.—215.
Clark Controller Company—68, 69, 70.
Clark Sales Corporation—22.
Cleveland Worm and Gear Company—244, 245, 246.
Columbia Electric Manufacturing Company—348.
Columbia Steel Company—62, 63.
Crocker-Wheeler Electric Mfg. Co., Division of Elliott Company—295, 296, 297, 298.
Crouse-Hinds Company—340, 341.
Cunningham Company, M. E.—71.
Cuno Engineering Corporation—209.
Cutler-Hammer, Inc.—46, 47, 48, 49.
Cyclone Fence Division, American Steel and Wire Company—62, 63.

De Laval Separator Company—207.
Delta-Star Electric Company—216, 217.
Diamond Power Specialty Corporation—125.
Dowell, Inc.—270, 271.
Dravo Corporation—274, 275.
Duraloy Company—349.

Eastern Pipe Maintenance Company—219.
Edison Storage Battery Division, Thomas A. Edison, Inc.—223, 224, 225.
Electric Controller and Mfg. Company—134, 135, 136, 137.
Electric Furnace Company—126.
Electric Products Company—30, 31.
Electric Service Manufacturing Company—226, 227.
Electric Storage Battery Company—128, 129.
Elliott Company—295, 296, 297, 298.
Elwell-Parker Electric Company—143, 144, 145.

Factory Stores Company—336, 337, 338, 339.
Farmers Engineering and Manufacturing Company—335.
Farval Corporation—244, 245, 246.
Federal Electric Products Company—59.
Foote Brothers Gear and Machine Corp.—25, 26, 27.

Garlock Packing Company—255, 256.
General Electric Company—278, 279, 280, 281, 282.
Gerrard and Company, A. J., Maintenance Division—11.
Gerrard and Company, A. J., Materials Handling Division—347.
Gould Storage Battery Corporation—352.

Hagan Corporation—146, 147.
Harnischfeger Corporation—80.
Hauck Manufacturing Company—23, 24.
Heil Process Equipment Corporation—346.
Hodson Corporation—285.
Holophane Company, Inc.—32.
Homestead Valve Manufacturing Company—264, 265.
Hunt and Son, Inc., C. B.—350, 351.
Hyatt Bearings Division, General Motors Corporation—286, 287.
Hyde Park Foundry and Machine Company—283.

Ideal Industries, Inc.—76.
Industrial Heating—101.
Iron Age—91, 92.
Iron Lung Ventilator Company—43, 44, 45.
I-T-E Circuit Breaker Company—252, 253.

Joy Manufacturing Company—56.

Keystone Lubricating Company—293.
Kinney Engineers, Inc., S. P.—3.
Koppers Company, Inc.—306, 307.

Leeds and Northrup Company—99, 100.
Lewis Foundry and Machine Division, Blaw-Knox Company—276, 277.
Linde Air Products Company, Unit of Union Carbide & Carbon Corp.—355, 356, 357, 358, 359, 360.
Link-Belt Company—117, 118, 119.
Lintern Corporation—4, 5.

McDowell Company, Inc.—324.

Magor Car Corporation—2.
Manning, Maxwell and Moore, Inc.—95.
Markal Company—292.
Martindale Electric Company—205, 206.
Matthews and Company, James H.—302.
Medart Company—148.
Meehanite Metal Corporation—93.
Mesta Machine Company—288, 289, 304, 305.
Midwest Lighting Products Company—57.
Minneapolis-Honeywell Regulator Company, (Industrial Division),—314, 315, 316.
Morgan Construction Company—344, 345.
Morganite, Inc.—210.

National Alloy Steel Division, Blaw-Knox Company—276, 277.
National Carbon Division, Union Carbide and Carbon Corp.—355, 356, 357, 358, 359, 360.
National Electric Coil Company—84, 85.
National Roll and Foundry Company—263.
National Tube Company—62, 63.
Nelson Stud Welding Division, Morton Gregory Corporation—294.

Ohio Carbon Company, Inc.—284.
Ohio Electric Manufacturing Company—60, 61.
Okonite Company—221, 222.

LIST OF EXHIBITORS—(Continued)

Osborn Manufacturing Company—311, 312.

Pannier Corporation—325, 326.
Penton Publishing Company—81, 82, 83.
Pittsburgh Gear Company—96, 97.
Pittsburgh Rolls Division, Blaw-Knox Company—276, 277.
Plibrico Jointless Firebrick Company—323.
Poole Foundry and Machine Company—319.
Post-Glover Electric Company—78, 79.
Pyle-National Company—98.

Railway and Industrial Engineering Company—254.
Ramtite Company—328, 329.
Ready-Power Company—141, 142.
Reintjes Company, George P.—12, 14.
Reliance Electric and Engineering Company—250, 251, 266, 267.
Rice and Company, Inc., Cyrus W.—327.
Riehle Testing Machines Division, American Machine and Metals, Inc.—8, 9.
Rockbestos Products Corporation—220.
Roller-Smith Division, Realty and Industrial Corporation—50, 51, 52.
Rollway Bearing Company, Inc.—203, 204
Rust-Oleum Corporation—322.

Salem Engineering Company—247.
Selas Corporation of America—110, 111, 112, 114.
Shaw Box Crane and Hoist Division, Manning, Maxwell and Moore, Inc.—95.
Sheffield Corporation—291.
Shell Oil Company, Inc.—353, 354.
Sherman Electric Company, Inc.—1.
Simplex Wire and Cable Company—301.
SKF Industries, Inc.—248, 249.
Socony-Vacuum Oil Company, Inc.—268, 269.
Solvent Service, Inc.—330.
Speer Carbon Company—262.
Square D Company—72, 73, 74, 75.
Steel—81, 82, 83.
Superior Carbon Products, Inc.—303

Tennessee Coal, Iron and Railroad Company—62, 63.
Texas Company—342, 343.
Tide Water Associated Oil Company—108, 109.
Timken Roller Bearing Company—104, 105, 106, 107.
Tool Steel Gear and Pinion Company—240, 241.
Trabon Engineering Corporation—29.
Trion, Inc.—58.
Trumbull Electric Manufacturing Company—259, 260, 261.

Union Carbide and Carbon Corporation—355, 356, 357, 358, 359, 360.
Union Fire Brick Company—53.
Union Steel Castings Division, Blaw-Knox Company—276, 277.
United States Steel Corporation—62, 63.
United States Steel Supply Company—62, 63.

Van Pelt Electric Company—218.
Voss Engineering Company—130, 131, 132.

Wagner Electric Corporation—257, 258.
Waldron Corporation, John—290.
Ware Fuse Corporation—7.
Wean Engineering Company, Inc.—273.
Wellman Engineering Company—272.
Westinghouse Electric Corporation—201, 202, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239.
Wing Manufacturing Company, L. J.—333.

Yale and Towne Manufacturing Company—317.
Yoder Company—400
Youngstown Sheet and Tube Co.—400

IRON AND STEEL EXPOSITION—HOURS

September 26 — Tuesday, 10:00 am - 10:00 pm

September 27 — Wednesday, 10:00 am - 10:00 pm

September 28 — Thursday, 10:00 am - 5:30 pm

September 29 — Friday, 10:00 am - 4:00 pm

NO REGISTRATION FEE

ASSOCIATION of IRON and STEEL ENGINEERS
1010 EMPIRE BUILDING • PITTSBURGH 22, PA.

RAIL SLITTING MILLS

By C. W. BARRETT
Chairman, Bar Mill Committee
Republic Steel Corp.
Cleveland, Ohio

. . . . when an adequate supply of rail is available, the slitting mill enables production of an economical product . . . .

▲ SINCE the early development of rolling mills for the production of steel bar products, rail slitting mills have played a very important part. Several of these mills are still in existence today. The rerolling and further refinement of rails into the many shapes and sizes can be traced back more than 80 years; so it is not a new subject.

Down through the years the future of these types of mills and products was not very encouraging for two reasons: (1) the supply of scrap rails, and especially the lighter footweight sections, was gradually diminishing for new rails through better manufacturing methods were giving far greater life, and the railway companies were replacing the light rails with heavier sections; (2) this type of product, since it did not conform to strictly chemical analysis, as is common in new steels, was looked on by the metallurgist with scorn. However, there have been a number of steel producers who have discounted these theories, and today we have several modernized mills which are keeping pace with the regular bar mills and produce a product that has a definite place in industry.

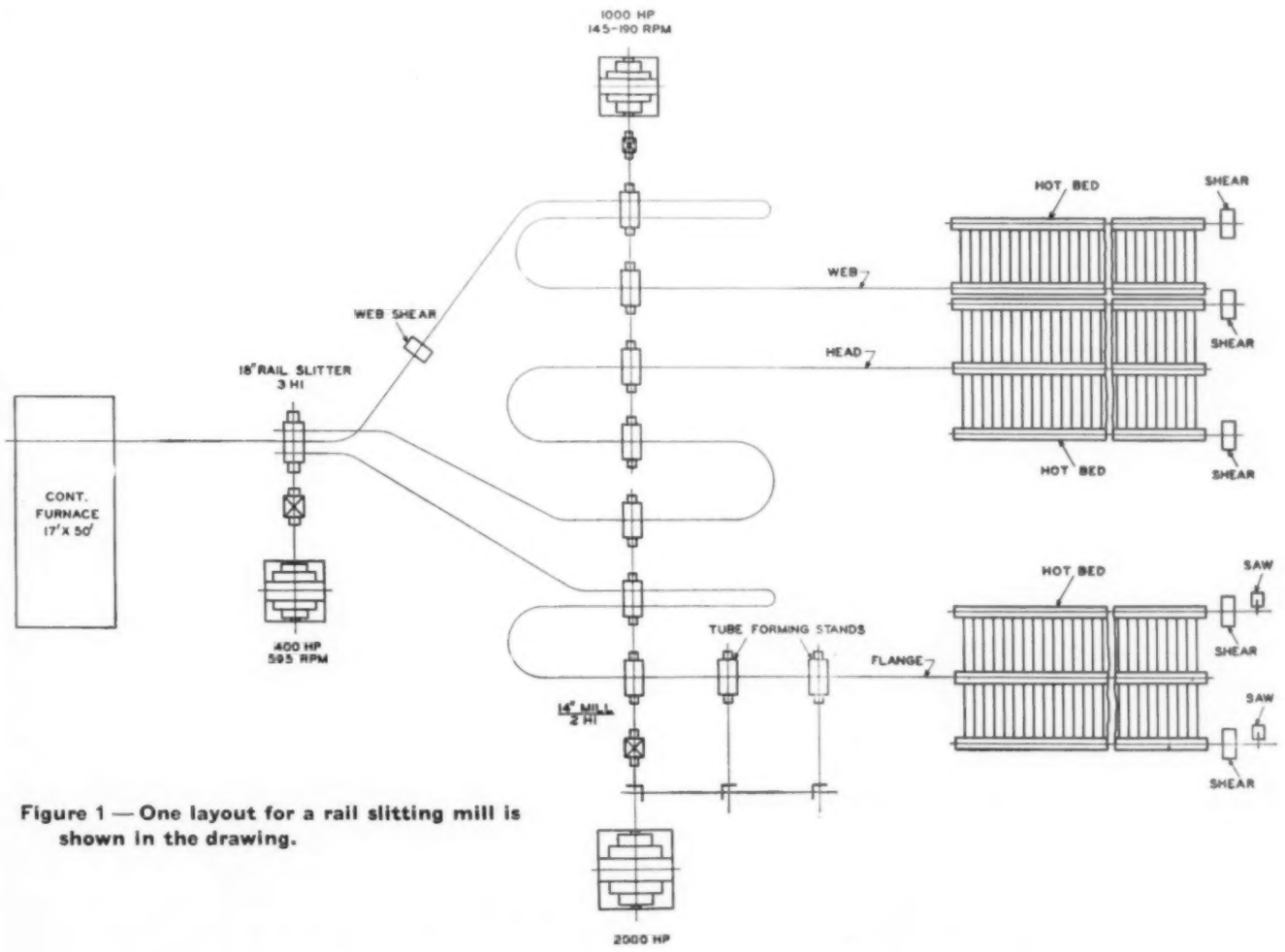


Figure 1 — One layout for a rail slitting mill is shown in the drawing.

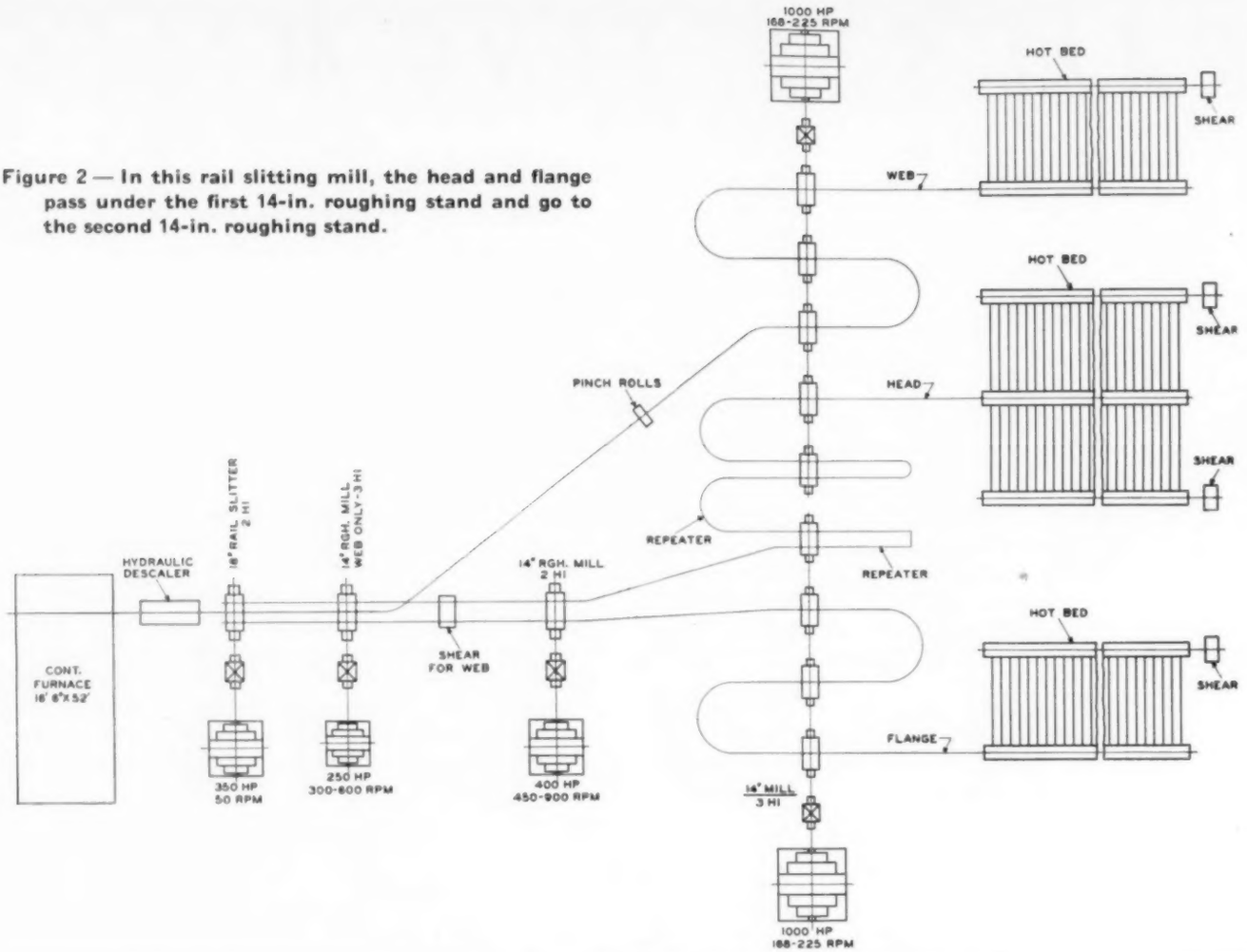


Figure 2 — In this rail slitting mill, the head and flange pass under the first 14-in. roughing stand and go to the second 14-in. roughing stand.

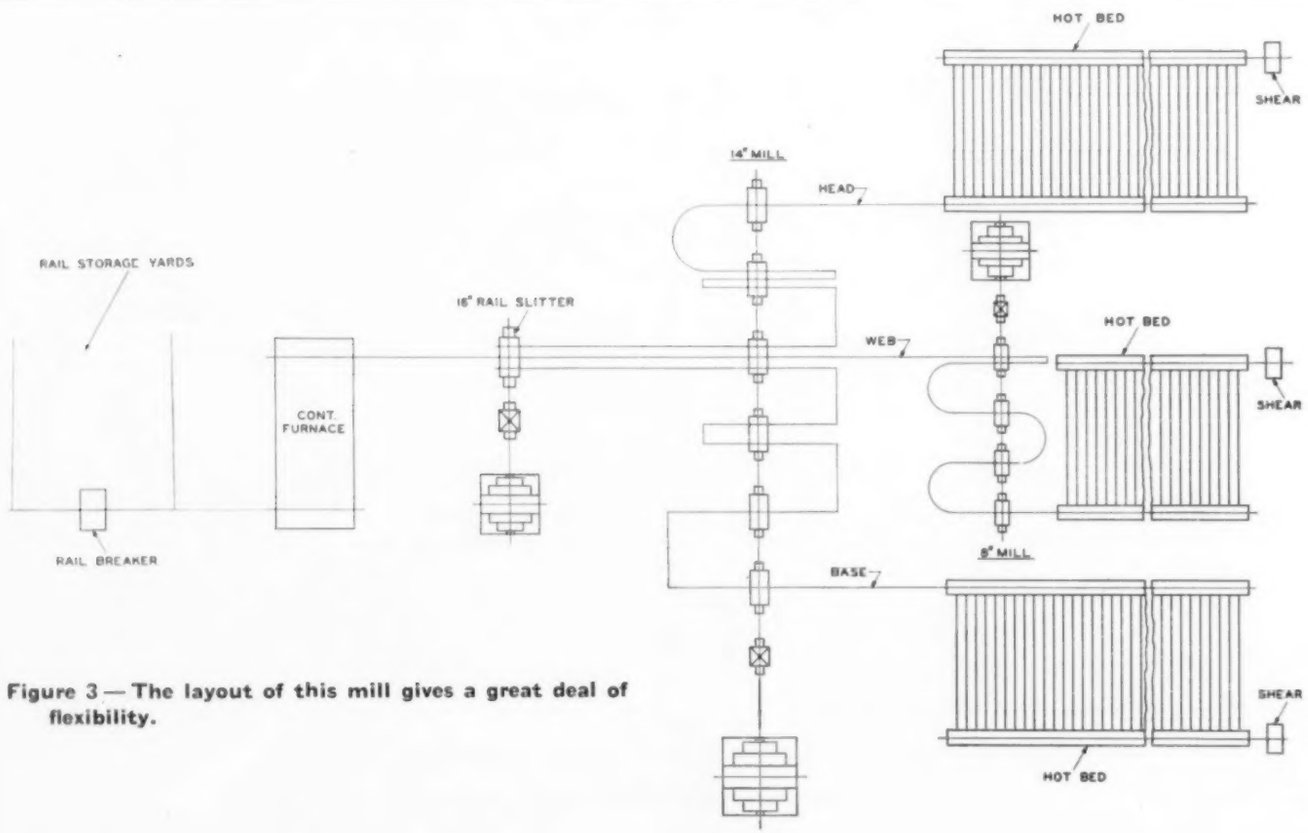


Figure 3 — The layout of this mill gives a great deal of flexibility.

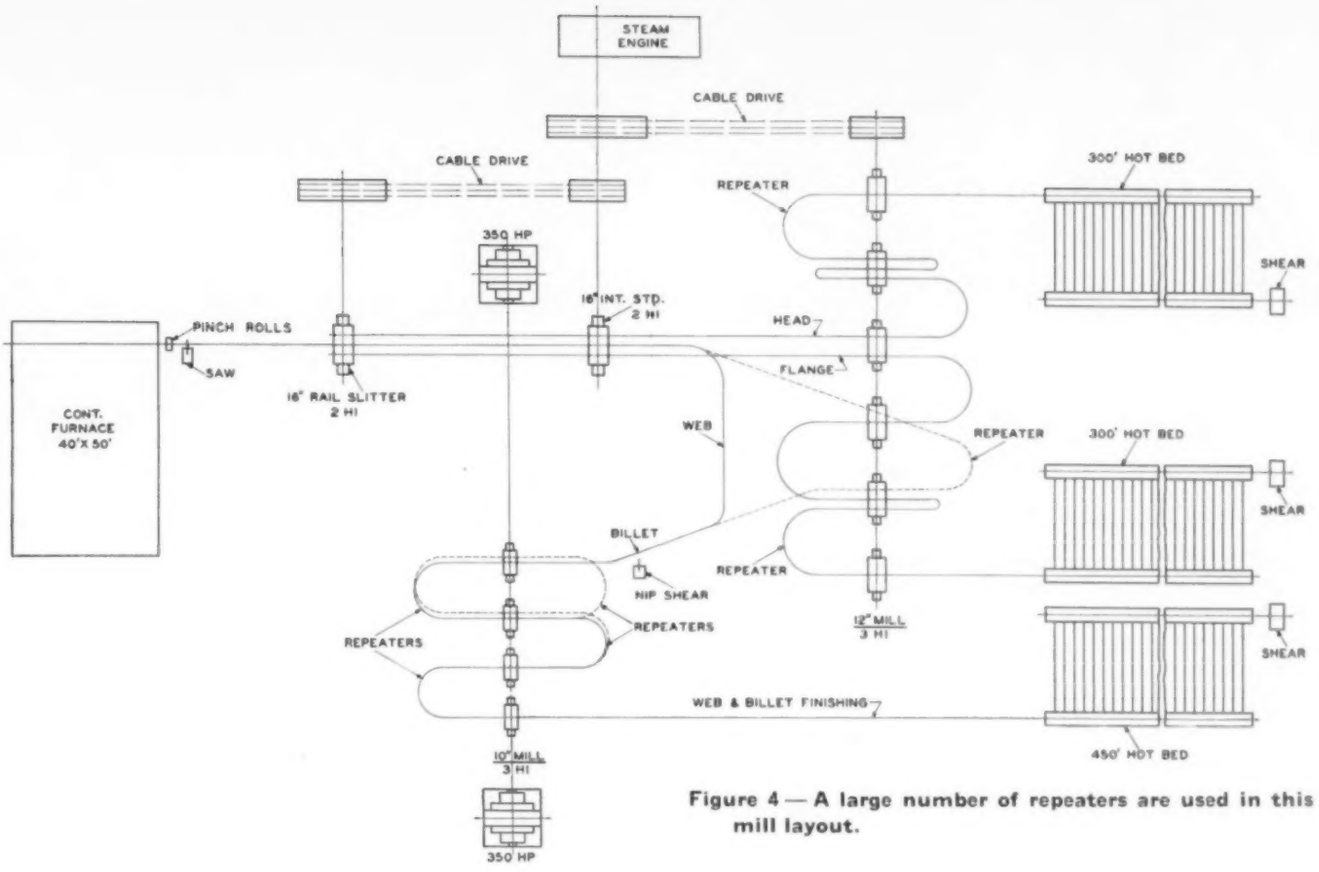


Figure 4 — A large number of repeaters are used in this mill layout.

The following figures will give an idea of the different types of mills in use today.

Figure 1 shows a rail slitting mill consisting of an 18-in. slitting stand and seven stands of 14-in. cross-country mill, followed by two continuous stands on the flange line for producing tubing. Note that the double outlet cooling bed has both shears and saws. This provides flexibility for bar products and tubing, and also short bar lengths. The head line also has a double outlet cooling bed complete with shears.

Figure 2 shows a mill with three stands in line preceding the finishing train. The first stand is an 18-in. slitter followed by a 14-in. roughing mill set at a higher elevation than the slitting stand. The head and flange pass under the first 14-in. roughing stand to the second 14-in. roughing, where they are reduced in size on their way to the finishing train. The first 14-in. roughing stand reduces web section only. In the slitting operation the web is raised up, while the head and flange are held down. A conveyor with pinch rolls carries the web section over to the finishing train. This mill is also using some repeater equipment as shown on sketch, and has a double shear outlet from the cooling bed on the head line.

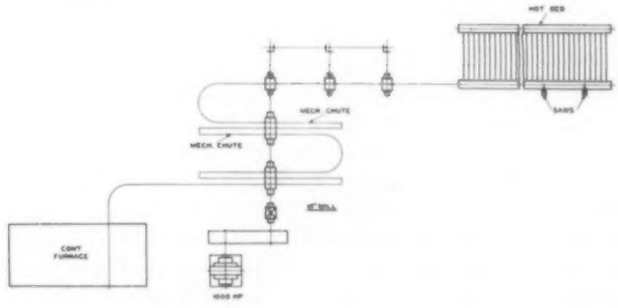
Figure 3 shows a slightly different type of mill where the finishing train is broken up into two mills with independent drives. This mill has a lot of flexibility with plenty of stands to make the necessary reductions.

Figure 4 shows still a different type of mill. Here there is a slitter stand and a roughing stand followed by 10 and 12-in. finishing mills. A very good feature about these mills is the length of cooling beds. This mill is suitable for rail slitting products as well as products from regular billets. In nearly all cases, the crop shears in the web line of all of these mills. This is to remove the end portion of the web with the bolt holes in it. If not removed, they usually break out—causing considerable trouble in the finishing mill. This mill probably employs more repeaters in the lineup than any other slitting mill, which is helpful in reducing the cost on mills such as these which require large crews.

Figure 5 shows a mill which is employed in making tubing products only. Two different methods of breaking the rails down will also be shown under Figures 8 and 9 to produce tubing.

Figure 6 shows a mill which has been in service for a long time. In the last few years, modern improvements have been made that have greatly increased its production. This mill now has a 16-in. two-high slitter stand individually driven, followed by a 16-in. two-

Figure 5 — This slitting mill is used for making tubing products.



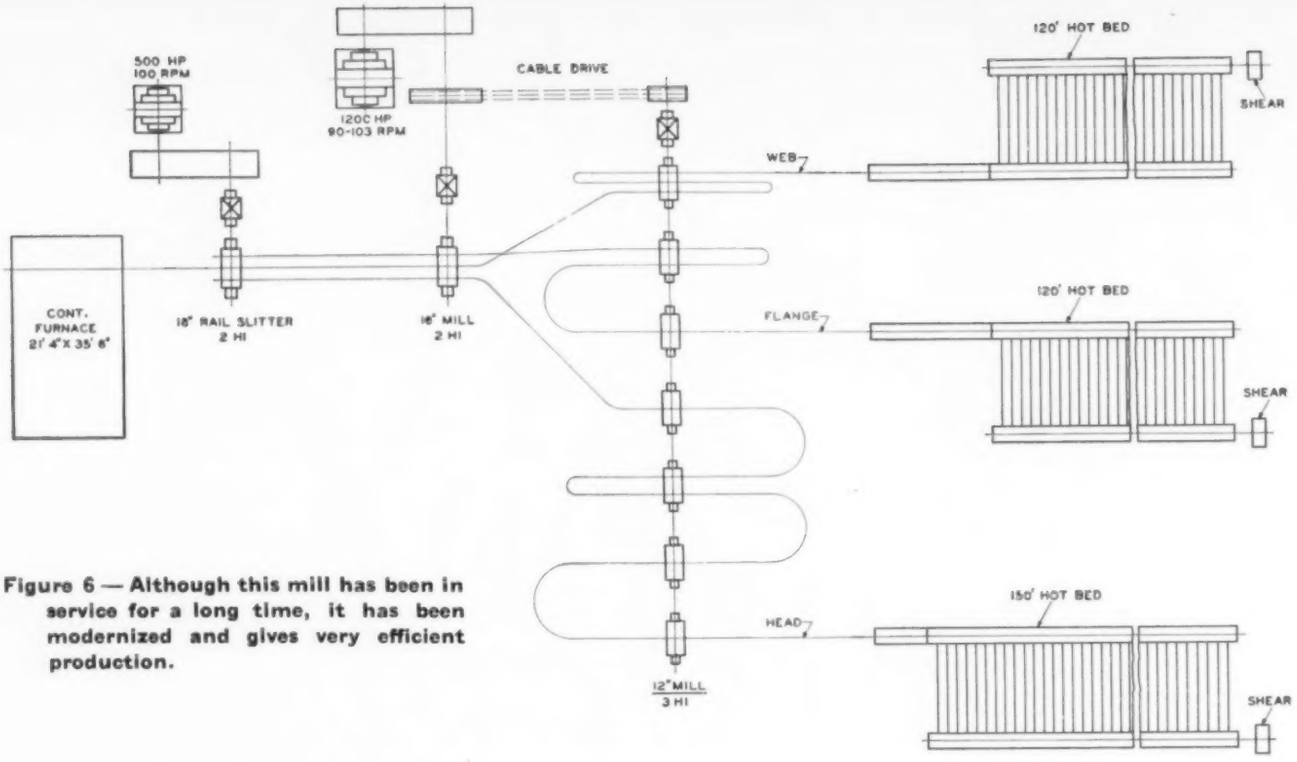


Figure 6 — Although this mill has been in service for a long time, it has been modernized and gives very efficient production.

high roughing stand. Views of this mill are shown in Figures 11, 12, 13, and 14.

The characteristics that are desirable in rail steel products are the rigidity and hardening ability that go with the higher carbons. The principal users of this material are the farm implement manufacturers and furniture manufacturers. A considerable amount also goes into fence posts for farms, transmission towers, reinforcing bars and many other uses too extensive to enumerate. Rails used for this purpose have served their usefulness in track and have been replaced with new rails. After being brought into the storage yard they are first conditioned. With the continuous pounding of the heavier roll equipment, the heads often become distorted with some of the metal forced out into a fin on the side of the head. See Figure 7. This has to be removed by chipping or burning. After this operation, the rails are laid out on the skids before the rail breaker where they are measured for length, and they are then nicked with a heavy axe or torch. The rail is then passed under the breaker which acts like a press against the puck placed on the opposite side to the nicked position on rail. In this manner, rails are broken to a definite length to suit furnace widths and product lengths. Some mill layouts provide for heating the complete rail length. It is then cut by hot saw to shorter lengths on leaving the furnace, prior to entering the slitter. After the rails leave the breaker they are conveyed to pockets or storage space where they are segregated into sizes; usually about six groups will cover the range of rail from 55 to 131 pounds. The width of web or "fish," as it is sometimes called, is the important characteristic for group classification. In addition to these, some classifications are made of large and small heads, as it is impossible to make some of the large sized products from rails with small heads. From these groups the size of rails are selected that are best suited for the products to be rolled. Here is where the order and scheduling department enters into the picture with a very important job. Each rail section after slitting is destined to three different types of finished products. In order to have good yields on each section it requires careful selection of rails at this point. They are then charged into the furnace, which is usually of a sloping continuous type, much the same way as billets or slabs are heated. After pushing the hot rail out of the furnace, prior to entering the slitting stand, it passes through a descaler where water around 1000 psi is applied. This removes most of the scale and prevents the plugging of scale in the slitter, entry, and delivery guides.

Different types of slitter rolls are used to produce different types of products. First a set of slitter passes used to produce tubing products is shown in Figure 8. The rail is slit into two pieces, and each of these two pieces go to make the same sized products. One piece is held back while the other is worked. This design shows how the rail is reduced from pass to pass.

Figure 9 shows the complete rail section, not slit, but reduced down in one piece to wide flats for tubing. Note these passes are all tongue and groove, and a definite fin or overfill is produced on the last pass preceding the straight-away finishing. This becomes the inside of the tube and aids in welding.

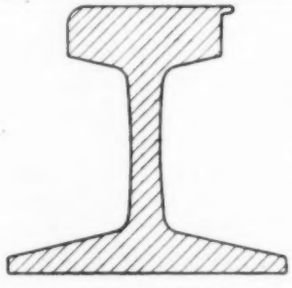


Figure 7 — Under the pounding of railroad service, fins are formed at the edge of the rail as shown in this diagram.

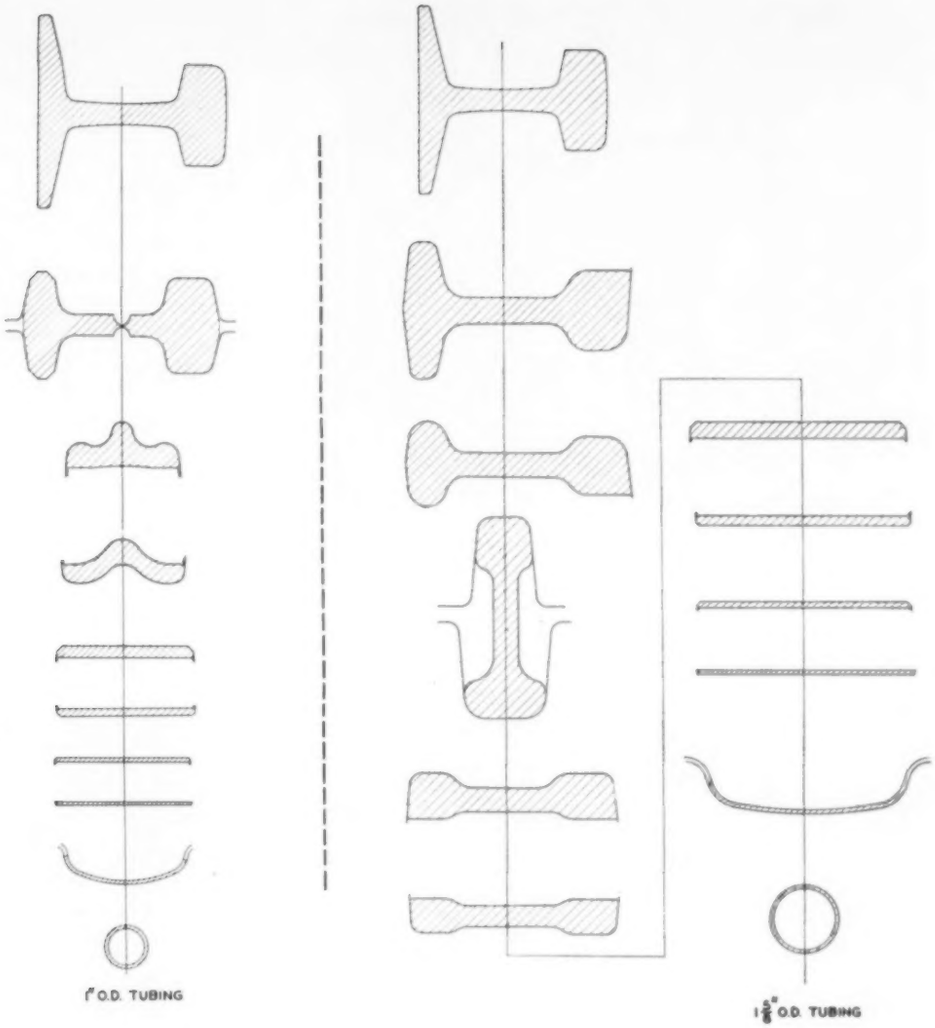
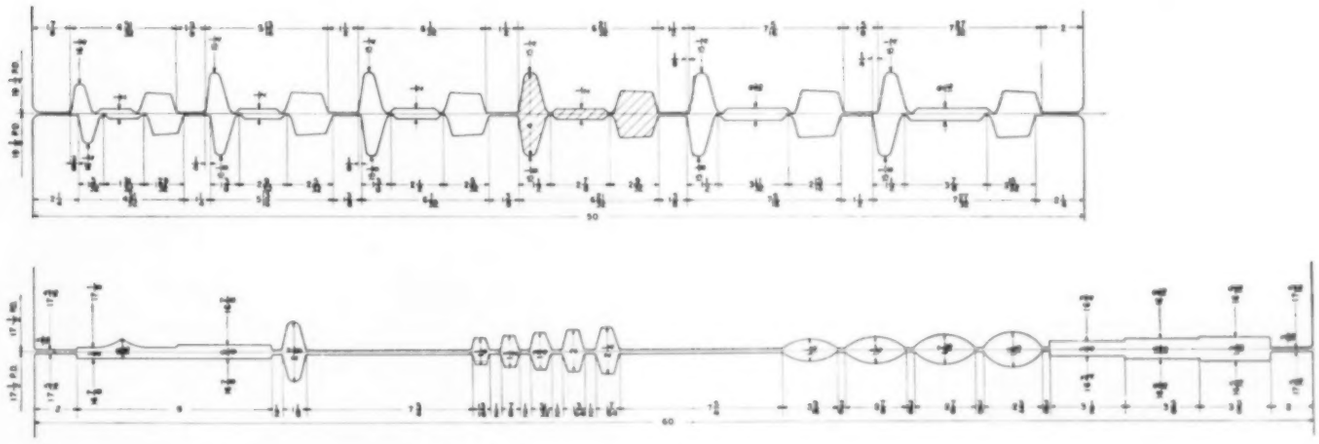


Figure 8—(left) Both parts of the rail make the same product in this series of passes.

Figure 9 — (right) Tubing is made from the rail section shown but without slitting the rails.

Figure 10 shows a set of slitter and roughing rolls commonly used in slitting rails into three distinct pieces. Note also the passes in the top and bottom slitter rolls are spaced differently. This prevents the damaging of the slitter points in the passes not being used and adds to the life of the roll. Since it is not practical to run the slitter points together, they are set in the mill at about 0.020 in. parting. When the rail enters the rolls, the rolling forces cause deflection in the rolls and the points move farther apart. The term slitting rolls is actually a misnomer, as the rolls do not actually slit the bar. This is done with the delivery guides and is usually accomplished with a bullhead guide on the bottom web which forces the web up, while the head and base are held down. Another method is to make the web guide wider at the head than at the nose, thus forcing the flange and head outward from the web. As the rail leaves the furnace it rides on one side of head

Figure 10 — The set of rolls shown is used when the rail is slit into three distinct parts.



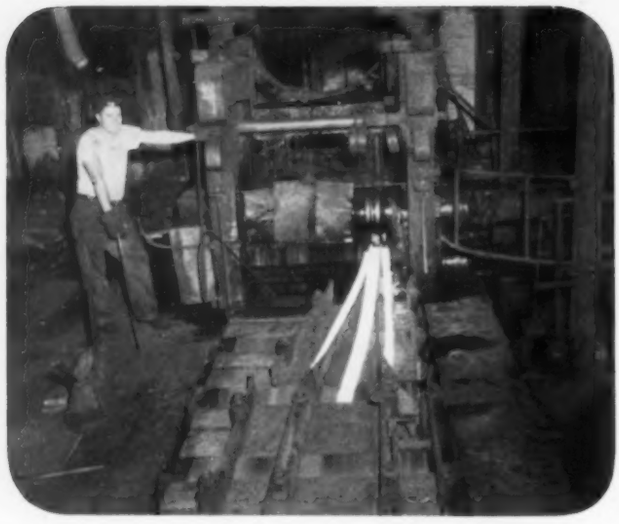


Figure 11 — The three pieces of the rail are shown leaving the slitter.

Figure 12 — Photograph shows the roughing stand of the mill whose layout is given in Figure 6.

and flange in an angular position. This must be righted to a parallel position before entering the slitter. This is accomplished by movable table roller sleeves or a solid type of entry shoe mounted on a rest bar.

The reduction of the rails in the slitting pass on head, web, and flange is varied by the roll designer, and depends somewhat on the size of product they wish to produce in a given number of passes. In many cases, work is placed only on the head and flange; while others choose to reduce the cross section of all three parts at one time. The type of guides used on entry and delivery side of the slitter is the important key to good slitting mill operations. The bullhead guide must be of a denite length and properly positioned on the roll to give satisfactory results. If the web is to be raised, the bottom guide must be the bullhead guide. This guide has an enlarged portion or bump at the front end where it rides the roll. This throws the web up and tears the web from the head and flange. The only way to properly locate this bump is by trial and error; and the height of the raised portion required will vary with the size of rails slit, but will likely be in the range of $\frac{1}{4}$ to $\frac{3}{8}$ in. above the plain surface of the guide. Since the guides are continuously riding the roll, they have a tendency to wear short after a few turns and will require a new point and the bullhead to be built up. The top guide must be made much shorter than the bullhead guide to let the web raise.

Figure 11 shows the slitter stand from the delivery side. After leaving the roughing stand where all three pieces enter at one time, they are each conveyed to the finishing train where they are further reduced to the finished product.

Figure 12 shows a roughing stand. Figure 13 shows the finishing train. This type of mill creates a complicated problem for the roller and assistant. As stated before, three products are being produced at the same time. Trouble on one finishing train holds up production on the other two. After leaving the finishing stands, the bars are run out on three cooling beds, one for each of the head, web, and base, which are equipped with shears. Usually a mill of this type is faced with cutting bars to short lengths with a lot of size changes.

Figure 14 shows the flange conveyor from roughing stand to finishing stand. Figure 15 is a diagram showing the types of products that are produced from rail steel and what part of the rail the shape is usually made from. There has been no attempt made to show

Figure 13 — The finishing train of the slitting mill is producing three products at the same time.

Figure 14 — Flange conveyor from roughing stand to finishing stand.

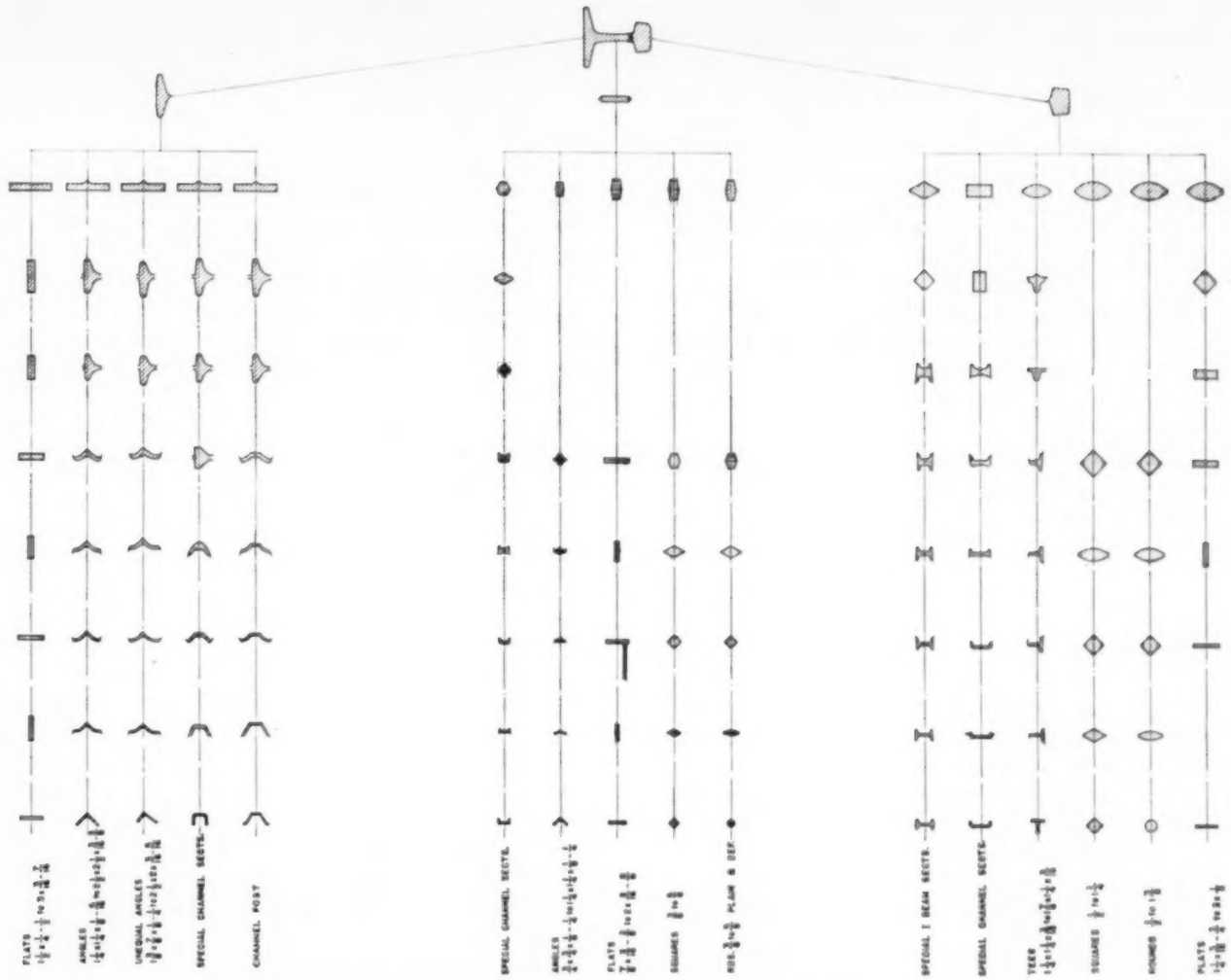


Figure 15 — A large number of products can be produced on the slitting mill.

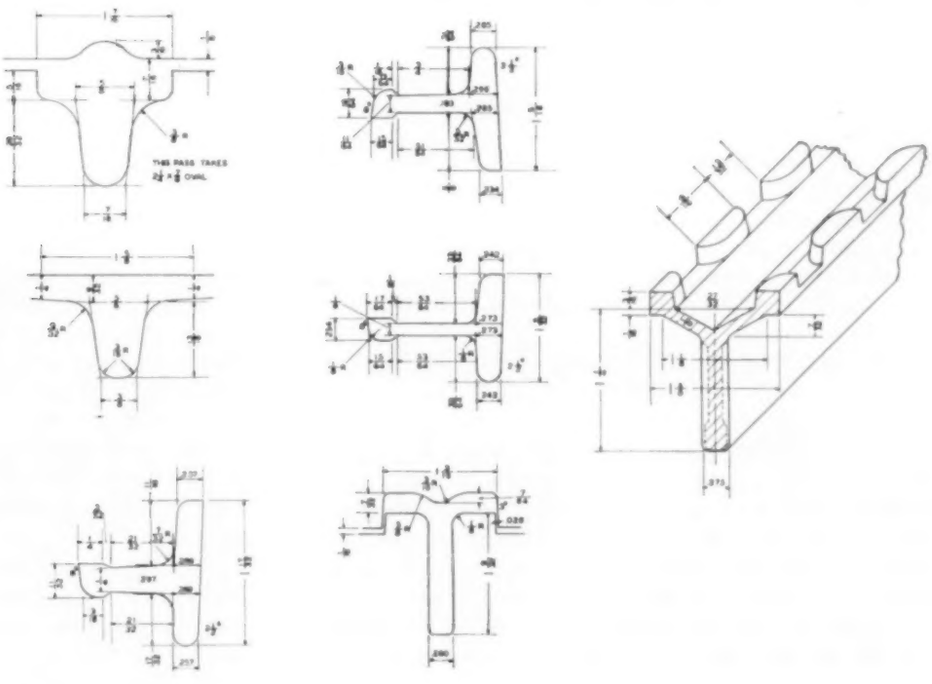


Figure 16 — The drawing shows a fence post section design which is produced on the slitting mill.

all the different shapes of products produced from rails, but they will follow a pattern similar to what has been shown here. Naturally on a rail slit into three pieces, tubing products would be formed from the rail base. The head of the rail constitutes the greater area, so naturally, the heavier sections are produced from this portion, and the following products are produced:

Flats $1\frac{1}{4} \times \frac{3}{16}$—$\frac{3}{4}$ to $3 \times \frac{1}{8}$.
Rounds $\frac{1}{2}$ to $1\frac{3}{8}$, also deformed bars.
Squares $\frac{1}{2}$ to $1\frac{1}{4}$.
Tees $1\frac{1}{4} \times 1\frac{1}{4} \times \frac{3}{16}$ to $1\frac{7}{8} \times 1\frac{1}{4} \times \frac{3}{16}$.
Special channel sections and special I-beams.

The web fits naturally into the lighter footweight groups, such as the following:

Rounds $\frac{3}{8}$ to $\frac{5}{8}$ plain and deformed.
Squares $\frac{3}{8} \times \frac{5}{8}$.
Flats $\frac{7}{8} \times \frac{3}{16}$—$\frac{3}{8}$ to $2 \times \frac{3}{16}$ to $\frac{3}{8}$.
Angles $\frac{3}{4} \times \frac{3}{4} \times \frac{1}{8}$—$\frac{1}{4}$ to $1\frac{1}{4} \times 1\frac{1}{4} \times \frac{1}{8}$—$\frac{1}{4}$.
Also special channels in the small ranges.

The base or flange of the rail is used to produce the following:

Flats $1\frac{1}{2} \times \frac{1}{4}$—$\frac{1}{2}$ to $3 \times \frac{3}{16}$—$\frac{7}{16}$.
Angles $1\frac{1}{4} \times 1\frac{1}{4} \times \frac{1}{8}$—$\frac{5}{16}$ to $2\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{16}$—$\frac{3}{8}$.
Unequal angles $1\frac{3}{8} \times \frac{7}{8} \times \frac{1}{8}$—$\frac{1}{4}$ to $2\frac{1}{2} \times 2 \times \frac{3}{16}$—$\frac{5}{16}$.

Channel posts, special channel sections, and larger miscellaneous shapes, some small rounds and squares can also be produced off the flange line.

Figure 16 shows a fence post design which is rolled from the head line. The projections on the base for holding the fence wire is completely formed in the finishing pass. This kind of rolling practice creates a terrific load on the finishing pass and wears out rolls quickly.

While the products produced from rail slitting mills are usually light in foot weights, the tons per hour you can expect from these mills is between 20 to 25 tons on the average from 100 lb rails.

DISCUSSION

PRESENTED BY

A. D. BAILLIE, Works Manager, Burlington Steel Co., Ltd., Hamilton, Ontario, Canada

C. P. HAMMOND, Superintendent of Rolling Mills, Rotary Electric Steel Co., Detroit, Mich.

C. W. BARRETT, Chairman, Bar Mill Committee, Republic Steel Corp., Cleveland, Ohio

EDWARD WINWOOD, Roll Designer, Crucible Steel Co. of America, Parks Works, Pittsburgh, Pa.

GEORGE PIMLOTT, Roll Designer, Republic Steel Corp., Cleveland, Ohio

A. D. Baillie: It is true that there have been many types of slitting mills developed since the start of the industry, and this paper very clearly outlined the principles. There have, of course, been many improvements since the start and many of our rail slitting mills today have reached a very high standard of efficiency.

I could not take exception to any of his comments, but I might say that the rail slitting industry contributed a great deal in the recent national emergency by the varied products which they rolled. The high quality of these products are assured when one realizes that the raw material used in slitting mills is one of the finest and most carefully inspected products of the steel industry today.

C. P. Hammond: Would Mr. Barrett give us some idea as to the production of these rail slitting mills; that is, the tons per hour or the tons per eight-hour shift?

C. W. Barrett: It ranges from somewhere around twenty to twenty-five tons per hour; that seems to be the average in a majority of cases. There are, of course, some mills that are probably doing better than that.

Edward Winwood: You spoke about one of the mills where the web went through the rougher, and the flange and the head, both spaced under the rougher to the finishing train. What is the object of that?

C. W. Barrett: The primary reason for this is to be able to deliver the head and flange in a straight line to the finishing mills and thus eliminate the necessity of spreading the sections to accommodate guide equipment.

In this particular operation the web is raised up as part of the slitting operation and it is then conveyed to another stand for finishing, and since this part of the rail is the lighter section, it is easier to divert into the desired direction and usually requires less passes.

Edward Winwood: In other words, it is to even the time elements of the three sections of the rail?

C. W. Barrett: That is right.

Edward Winwood: When you split the rail into two or three parts, what do you do with the rest of the men on the other stand?

C. W. Barrett: Fortunately at most of the plants which slit rail they are prepared to handle three products at the same time and in that case three piece slitting is the only method used. Those companies that slit into two pieces, or do not slit the rail, usually have only one finishing train such as used in making tubing so the crews are not a problem.

George Pimlott: I would like to ask the speaker how the advent of so many buses and trucks hauling freight and passengers, will affect the number of worn rails that will be available for use in rail slitting mills? If worn or scrap rails are not available, can you use regular billets in your roughing, or does the existence of the mill depend on old rails?

C. W. Barrett: This is a pretty hard prediction to make and is the thing that has retarded the development of rail slitting mills over a considerable number of years and has kept rail steel products at a minimum. The future prospect for these mills to obtain rerolling rails is anything but good. With the advent of heavier rails and better operating equipment, the railroads do not require the replacements as in the past. As Mr. Pimlott said, buses and trucks are handling much of our transportation today, which will, no doubt, have its effect on slitting mills and their ability to purchase rails.

Billet practice can be adapted by most of the slitting mills with a reasonable amount of revamping. Some of the mills are now doing this sort of thing and quite well.

Design and Maintenance of Crane Runways

. . . . crane runways are subjected to much greater and more severe forces than generally realized . . . . as a result proper and adequate design is required if excessive maintenance is to be avoided . . . .

By V. L. SMITH
Assistant to Chief Engineer
Fort Pitt Bridge Works
Pittsburgh 10, Pa.

1. *Purpose of the runway*—Does it support a slow moving, seldom used power house crane, or a high speed crane that seldom carries a capacity load, such as is common in a machine shop, or a stripper or charging crane whose more rigid mechanism imparts a peculiar racking to the runway, or the brutally used cranes in the open hearth building?

Obviously, the reactions to the runway vary and consequently the allowable unit stresses should be varied correspondingly. Or, vary the percentage of impact for vertical load and percentage of live load for end thrust.

2. *Direction of loads*—This is quite simple. The loads are vertical, transverse and longitudinal. If the crane is out of line, and this is not unusual, it will bind on the rails causing torsion. We can neglect this effect on the runway except for the fact that it produces excessive wear on the rails.

3. *Reaction to loads*—All loads go through the crane runway girders into the columns. The connection of girders to columns is the big problem in maintenance, or at least, redriving these connections is the thing that steel erectors are usually called in to do. Replacing rail clips and rails is quite commonly done by the plant maintenance force.

4. *Design*—Remember that Coopers E60 loading is small potatoes compared to many crane loads. Little need be said about the design of the girders. They range from a simple rolled beam, or beam and channel, to huge single or double plate girders or trusses. The trusses have the problem of combined bending and direct stress in the top chords. Beam and channel girders are usually not economical in regard to weight of material, but simplicity of fabrication and upkeep make them economical in the overall picture. Incidentally, the beam with the channel on top is far superior to the beam with the channel on the side.

The average designer has no trouble designing the girders in accordance with the specifications given him. The specifications should be varied for the crane and its use. The writer would not hesitate to use 18,000 psi, no impact and no end thrust for a power house crane, but in the open hearth, he would advise using an impact of 50 per cent on vertical loads and a lateral thrust of 20 per cent of the lifting capacity of the crane plus the weight of the trolley, applied at each rail.

The design of details is another problem and will be discussed later.

5. *Rails and fastenings*—It is poor economy to use light rails. Replacement is expensive. Welded or fitted splices prolong the life of the rails but their use complicates the problem of thermal movement. An expansion joint should be introduced at about 100-foot intervals. Special tough steel must be used for the expansion joints or their maintenance will be troublesome.

Rail fastenings vary from the hook bolt or standard clamp to steel castings fitted to the rail and reamed in place to perfect fit and alinement or welding the rail to the girder. Some engineers want both rails fastened rigidly; others prefer one rail floating, and a few want both rails floating. The writer's preference is to clamp one rail rigidly with an adjustable clamp and permit the other rail to float. A.I.S.C. two bolt clamps are nicely adaptable. Use a flat upper plate for the fixed rail and bent upper plate and thicker washers for the floating rail. The fabricator and erector will not like it, but the maintenance men will.

6. *Types of runway*—The usual types are the open A-frame runway, the A-frame with overhead lateral bracing system, the runway supported on brackets from a column of uniform cross section, and the runway supported directly on a double shaft column. The latter two types are usually enclosed and called a building, but the enclosing elements may be omitted and the resulting structure is usually called an open yard runway.

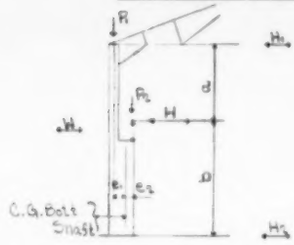
Gantry cranes and circular runways used in round houses are a special type and will not be discussed in this paper.

There are also several types of monorail cranes. Those that run on the bottom flange of a beam usually overstress the beam flange laterally and eventually bend the beam flanges down.

7. *The maintenance problem*—Aside from painting and rail wear, there are just three maintenance problems: alinement, loose connections, and damage to the column shaft below the crane.

Most alinement problems are due to settlement of foundations or the lack of an overhead lateral bracing system. The elevation of the columns should be checked at regular intervals, and any settlement should be immediately rectified by jacking up the columns. This can be impractical as for instance the center row of columns in the open hearth where the columns are encased for protection from spills and are also tied in to the furnace structure. For such cases, the girder con-

Design of Mill Building Col.



- P_1 = Roof Load (D+L)
- P_2 = Vertical Crane Load
- H = Crane Thrust
- W = Wind
- e_1 = Ecc. of P_1
- e_2 = " " P_2
- S = Sec. Mod. Upper Shaft
- S_o = " " Lower Shaft O.S. Face
- S_i = Sec. Mod. I.S. Face Lower Shaft

Assume that point of Contraflexure is at the base of rail. It will actually figure to be reasonably close to this point and will move up or down the column with the normal variations in load application.

Let $H_1 = \frac{H_2}{2}$ and $H_2 = H - H_1$. Assume that H_1 is distributed thru bott. chord lateral bracing to other building cols. not under full load.

Then consider load application to the upper and lower shafts of columns, as indicated in Figs. 1 & 2

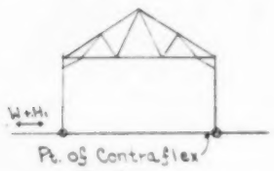


Fig 1

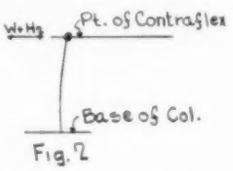
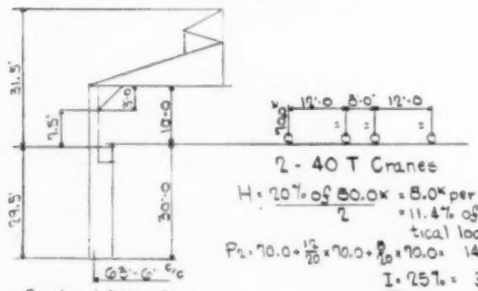


Fig. 2

Note that overturning by wind seldom enters into the design since the dead load of the structure usually equalizes it.

An Actual Design



Bents at 20'-0" Ctrs.

2 - 40 T Cranes

H = 20% of $\frac{80.0^K}{2}$ = 8.0K per wheel = 11.4% of vertical load

$P_2 = 70.0 + \frac{12}{20} \times 70.0 + \frac{8}{20} \times 70.0 = 140.0^K$

I. 25% = 35.0K
DL = 5.0K
180.0K

H = 11.4% of 140.0 = 16.0K
$H_1 = \frac{30}{45} \times 16.0 = 12.0$

$H_2 = 16.0 - 12.0 = 4.0$
$W = 20' \times 31.5' \times 20^{\#} \div 2 = 6.3^K$
$P_1 = \frac{64}{2} \times 20' \times 40^{\#} = 25.6^K$

Wind M - Upper Shaft = 6.3 × 90' = 567.0'K
Crane M - " " = 12.0 × 90' = 1,080.0'K
1,647.0

Try 14WF261
Unit Stress = $\frac{25.6}{17.04} + \frac{1647.0}{91.2} = 1.50 + 17.80 = 19.30^{\#}$ a

$W_R = 10.5' \times 12' \div 2.45 = 51.5$ Allow. $S = 15000 + \frac{1}{3} \cdot 20.000^{\#}$ a - OK

Or - 4 pl - 5" × 3½" × ⅜"
12 - 14" × ⅜"
} Will show a unit stress of 21.615# a an overload of 7%. The writer does not hesitate to use an overload of 10% on the upper shaft.

Lower Shaft	Area	Arm	I&M	2nd M	Ib
Try 1-27WF94	27.65	-	-	3267	115
1-13 [E 31.8	9.30	12.8	1186	1527	238
	36.95		118.6	47.99	353
				- 380	
				4419	

Ecc. = 118.6 ÷ 36.95 = 3.21
$S_o = 4419 \div 16.65 = 265$
$S_i = " \div 10.6 = 417$

$r_D = \sqrt{\frac{353}{36.95}} = 3.1$

	O.S. Flange	I.S. Flg.
$P_1 = A = 25600 \div 36.95 =$	690	690
$P_1 e_1 = S_o$ or $S_i = 25600 \times 9.65 \div 265$ or 417 =	+930	-590
$P_2 = A = 180,000 \div 36.95 =$	4870	4870
$P_2 e_2 = S_o$ or $S_i = 180000 \times 11.35 \div 265$ or 417 =	-7710	+4900
Wind M = ? 230 000 ÷ " " =	±8400	±5340
Crane M = 1,416 000 ÷ " " =	±5340	±3390
	Max +12520	+18600
	Min -14960	+1140

Alternate Section

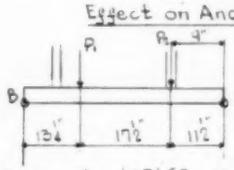
4 pl - 5" × 3½" × ⅜"
1 PL - 27" × ⅜"
1-13 [E @ 40
} Area 34.03 Will Show

Max.	+15930 +18370
Min.	-17190 + 770

Use of built up sections will produce more equally stressed columns. As loads increase and heavier rolled sections are used for columns, the unit stresses in the outside flange will decrease indicating that the column is wasteful of material in web and outside flange.

Moment at Base

Effect on Anchor Bolts & Foundation



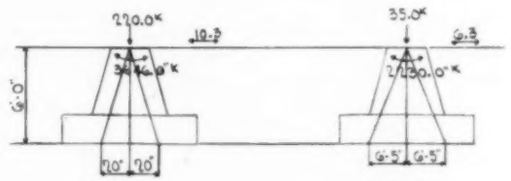
Wind M + Cr. M = 3646.0'K - to right
Resisting M = 180.0 × 9" + 25.6 × 29" = 2362.0'K
3646.0 - 2362.0 = 1284.0' K unbalanced to be carried to foundation thru bolts.

Moms. about 'B' { For Wind + Cr Mom. to Left, the resisting moment is greater - no uplift occurs.

But if Crane load is removed, we have

D.L. = 70.0K × $\frac{42.13}{2}$ = Wind Mom = ?.230.0'K
1808.0'K unbalanced M

$\frac{1808000}{4 \times 24000 \times 21.12} = 0.88$ net sq. in. in each of 4 Anchor Bolts



Case 1

3646.0 + 10.3 × 77 = 4388.0'K
4388.0 ÷ 220 = 20'

Case 2

2230.0 + 6.3 × 77 = 2684.0'K
2684.0 ÷ 35.0 = 77

Try Base 5' × 13'

$p^{\#} = \frac{220}{65} \pm \frac{6 \times 4388.0 \div 12}{5 \times 13^2} = 5900$ or $780^{\#}$ a'

$p^{\#} = \frac{35.0}{65} \pm \frac{6 \times 2684.0 \div 12}{5 \times 13^2} = 540 \pm 1600 = 2140$ or $-1060^{\#}$ a'

To allow for the resisting moment of the back fill, the writer prefers to modify the formula $p^{\#} = \frac{P}{A} \pm \frac{6M}{bd^2}$ to read $p^{\#} = \frac{P}{A} \pm \frac{4M}{bd^2}$

The above is not intended to be an accurate or good design, but merely to show that a long, narrow foundation is preferable and that the danger point may occur when the column in not loaded.

Figure 1 — This design example illustrates the procedure and assumptions upon which crane runway design should be based.

nections should be designed to make it possible to insert shims between column cap and crane girder without resorting to a major operation.

The back leg of open A-frames should always have slotted shim plates which can be removed or added to without removing the nut from the anchor bolt. This method will take care of lateral alinement.

For runways with overhead bracing systems, the bracing should always be continuous, forming a horizontal truss. This should not be designed with the idea of taking all wind and lateral thrust to the ground through the end bracing, for the simple reason that next week the owner will probably extend the building. The purpose of the lateral truss is to distribute the lateral crane thrust to several bents and to keep the building in line.

Knee braces cause most of the loose rivets between columns and crane girders. The loaded girder deflects,

the knee brace gets a heavy load, bends the column and the adjacent knee brace tends to lift the unloaded girder, pulling the rivets to the column cap in tension. Also, starting or braking the crane puts a longitudinal thrust in the girders which is transmitted into the columns. The diagonal bracing of the columns is usually in the plane of the top shaft, and the eccentricity between center of crane girder and plane of bracing is not properly compensated. Eliminate knee braces, add diagonal bracing in the plane of the crane girder, and use separate diaphragms to the column for each girder, and the loose rivet problem will be practically eliminated.

For some reason unknown to the writer, crane girders riveted directly to the face of the column with the rivets carrying the entire end shear seldom develop loose rivets. This method has fallen into the discard for two reasons. It is more difficult to erect, and crane operators feel more secure if they see the girders sitting on top of the columns.

As long as loads swing from crane, columns are going to be bumped. They should be designed to take and resist this treatment. Again, the use of the crane should be considered. For instance, one seldom sees battered columns in an open hearth building, while the columns in stock, scrap and billet yards usually show evidence of rough treatment. The answer is additional metal and the avoidance of unprotected outstanding legs of angles or beam flanges.

8. *Design of details*—Check beams for web buckling and bearing at the edge of the fillet. Be sure that end stiffeners have sufficient area and rivets and that they bear on corresponding metal in the column cap. Web rivets in the top flange must carry both direct stress and concentrated wheel loads. Many crane girders have too few rivets at the center. In the writer's opinion, milling web plates flush with the backs of angles does not provide the complete answer for resisting the wheel loads, because the resultant stress from horizontal and vertical loads is usually outside of the web plate and is resisted by the rivets in single shear. This is a point to remember in the design of welded girders. Obviously additional stiffeners are required. Rivet spacing must be watched to maintain the designer's net section.

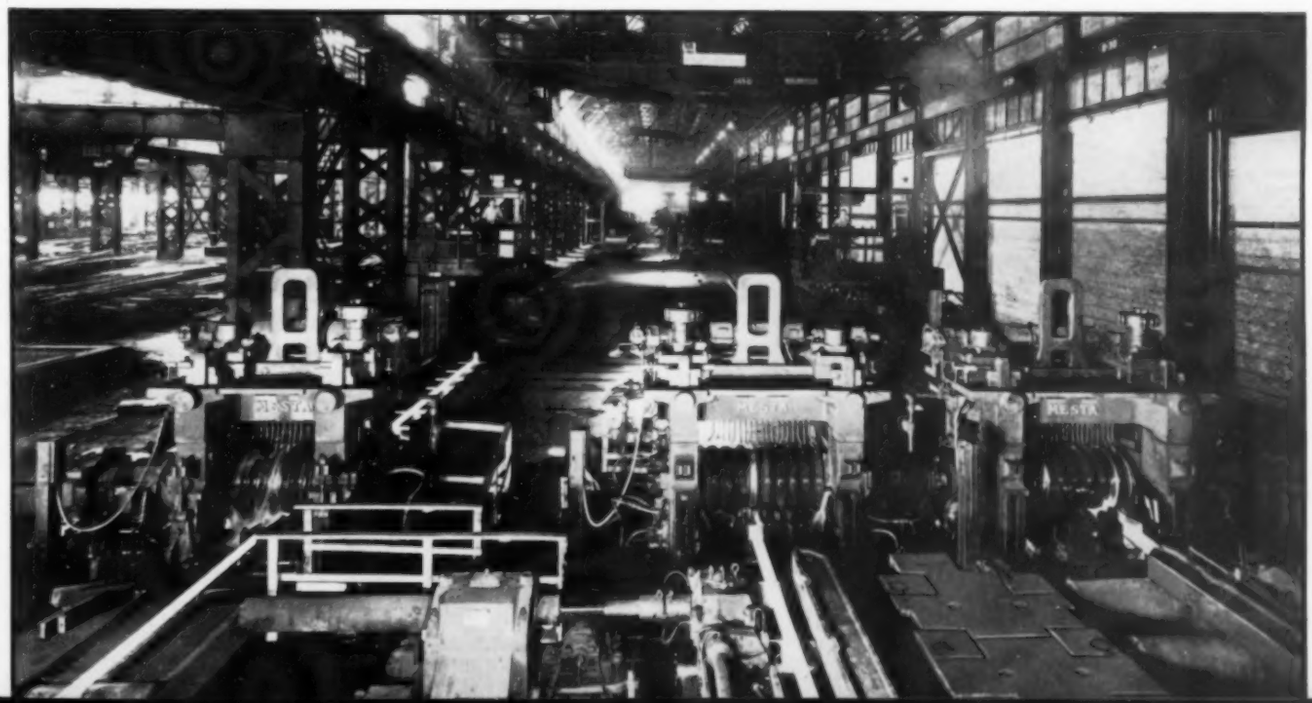
9. *Design of a mill building column*—The writer has studied all literature he has been able to secure; chased points of contraflexure all over the column; considered hinged ends and fixed ends; wind effect and crane thrust; and finally decided to design columns in accordance with a theory of his own, which has been producing satisfactory buildings. Before presenting this design for your consideration, the writer wishes to state that his favorite column is that used by J. F. Ferm, chief engineer of Crucible Steel Co.

This column consists of two shafts several feet apart, laced together, one directly under the crane girder and the other extending up to carry the truss. This produces a statically determinate bent that carries all wind and crane thrust directly into the foundations. The top shaft carrying the truss of course carries a bending moment due to wind in addition to the direct roof load, but the length to be considered is only from the top of the bent to the truss and is fixed at both ends. The result is a sturdy column with minimum weight and a rigid building. Some engineers object to the fact that this increases the total width of the building. For their benefit we present the following design.

For nomenclature and an actual design, see the design example.

Consider the column fixed at top and bottom and take the point of contraflexure at the top of the crane girder. Disregard wind below the point of contraflexure and take the wind above at 20 lb per sq ft divided between two columns, or more if it is a multiple aisle building. Take the horizontal crane thrust as 20 per cent of the lifting capacity of the crane on each column. Figure reactions from crane thrust at truss and base as if the column were a single beam. Consider that the reaction at the truss is carried through the lateral bracing system to other columns not under full load. Now

Figure 2 — Crane runways must be designed to withstand the severe stresses and abuse which occur as a result of crane operation.



consider that both wind and crane thrust are applied at the point of contraflexure. Then the unit stress in top shaft is $\frac{P_1}{A} + \frac{Wb}{S} + \frac{H_1 b}{S}$. The unit stress in the lower shaft is $\frac{P_1}{A} \pm \frac{P_1 e_1}{S} + \frac{P_2}{A} \pm \frac{P_2 e_2}{S} \pm \frac{Wa}{S} \pm \frac{H_2 a}{S}$.

The resultant flange stresses may seem unusual but tend to confirm the writer's belief that many columns have an excess of material in the outside flange and a shortage under the crane girder.

This column analysis, which necessitates the location of the neutral axis, shows that for many columns now in use, the allowable unit stress of steel on concrete and concrete on soil is exceeded. It also shows that for many cases involving a crane runway on each side of the columns that maximum stresses are produced with only one crane on the column.

Investigation of the bending moment at the base of the column shows that usually a very heavy crane leaves a relatively smaller unbalanced moment to be carried into the foundation than a light crane.

10. *Food for thought*—If we were designing a railroad trestle 50 ft high for an E60 loading and a gage of 65 ft, instead of the usual 4 ft 8½ in., we would promptly build a pair of towers for a 20 to 25 ft span, then probably a 60 ft span to the next tower, with provision for temperature expansion in every long span. But we will put a crane corresponding to an E200 loading on a practically unbraced column, and make no provision for expansion in 300 to 500 feet of track. And if some bracing interferes with operations, it is promptly removed.

11. *Cost and procurement*—The majority of runways and mill buildings are bought by the pound price, the fabricator to design the structure in accordance with the owner's specifications. Perhaps the purchasing agent was a little tough and the fabricator cut his price. A good designer can usually get this back by adding some weight where it does not affect fabricating costs, though not necessarily increasing the strength of the structure. If it is a lump sum job, he can find a way to save a little material.

If a good job is wanted, it is better to separate designing from fabrication. Be sure that the design shows how the critical details are to be made. If ten rivets are wanted at a point where five will figure, the design should show them. There are places where it is good long range economy to use this excess.

A design on which fabricators are willing to submit lump sum prices will result in lower prices, either per pound or lump sum, to the buyer.

A good design drawing for a mill building will show not only the various stresses, but the way angles or other members are turned; peak and heel details of trusses; location of intersection points; number of rivets required in lateral and diagonal bracing; a detail showing connection of crane girder to column; the rivet pitch on crane girders; a detail of the column base; how gable girts are to be framed, etc. If the designer knows shop practice (and he should) the resultant design will be more workable in the shop. The fabricator can make full use of his multiple and rack punches. Angles will have either leg long enough to take the standard punching. Ordering of material and detailing can proceed promptly. Also, if the designer will note that unused open holes are not objectionable, a larger number of duplicate pieces will ensue, eliminating much sorting by fabricator and erector.

The net result will be a little more time and cost in the preparation of the design and considerable less time and cost in detailing. The quoted prices will be more attractive because the fabricator can definitely estimate his costs without making allowance for unexpected requirements.

DISCUSSION

PRESENTED BY

JOHN J. MURRAY, Engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

V. L. SMITH, Assistant to Chief Engineer, Fort Pitt Bridge Works, Pittsburgh, Pa.

John J. Murray: There are two statements in Mr. Smith's paper that do not appear to coincide completely. First, the bottom chord bracing system, it is presumed from the paper, fixes the top of the column against translation, but in order to get a distortion diagram similar to the one shown on the blackboard, or to produce a portal system which has a single point of inflection at some point in the column length, it becomes obviously necessary for the top of the column to translate, as is indicated in the diagram.

I wonder if Mr. Smith would care to clarify this point.

V. L. Smith: The purpose, in my mind, of the lateral truss is simply to spread a horizontal reaction to additional bents in the building that are not loaded at the time. Of course, you want a good connection from your truss to the column sufficient for direct load and movement. The only thing that I base this theory on is that the buildings I have been designing have been satisfactory. I know that Jones & Laughlin designs are always pretty heavy, much heavier than the average design we get. We fabricate quite a number of buildings for them and also for Republic, and we find that generally J. & L. are among the heaviest designs we get.

On Mr. Murray's question on translation of moment from column to bottom chord lateral system, he is correct in that it is not practicable to effect this translation. The value of the continuous bottom chord bracing is that it does not permit the top of the horizontally loaded column to sway out of line with the other columns. Limiting this deflection reduces the moment at the truss connection and induces a partial simple beam action into the column. Of course, this will move the point of contraflexure and affect the shape of the deflection curve.

The writer has seen the tops of columns sway as much as eight inches out of line in buildings not having continuous bottom chord bracing. In this case, each bent of the building has to take the full horizontal load. With continuous bottom chord bracing, the adjacent bents help carry the load. In fact, no building designed as a series of individual bents will react in accordance with that theory when continuous bottom chord bracing is introduced.

Couplings for Rolling Mill Drives

By WALTER P. SCHMITTER
Chief Engineer
The Falk Corp.
Milwaukee, Wis.

. . . . the influence of resilience on dynamic loading is discussed in this paper . . . .

▲ THE design of a flexible coupling is intimately related to the operational characteristics of the rolling mill system to which it is applied. If it is kinematically unsound, it will impose undue forces upon the transmitted motion from the prime mover. On the other hand, it may serve as a protective agency in mitigating the influence of the reactionary loads from the mill upon other members of the train. This paper will be limited to a discussion of the efficacy of torsional resilience in flexible couplings for alleviating the mass elastic system from the effects of such disturbances. The evidence essential to a proper consideration of this function has not been adequately presented heretofore, largely because of the absence of quantitative treatment and test data.

GENERAL THEORY OF SHOCK REDUCTION

The torque which develops from the release of a given quantity of shock energy upon a shaft assembly will be inversely proportional to the deflection produced. Torque equals twice the energy divided by the deflection in radians. It follows then that the protection afforded by a torsionally resilient coupling under impact will depend upon the extent to which its elasticity influences that of the total system. Figure 1 defines the relationship between shaft twist and torque. The areas of the two triangles are identical, representing the potential energy of their systems, which must in both instances equal that of the applied energy. When the torsional resilience of the flexible coupling supplements that of the shafting, the resulting increase in deflection calls for a decrease in torque in order that the equation be satisfied.

CAPACITY OF COUPLINGS FOR INTERNAL WORK

This statement of the theory reveals that the coupling must contribute measurably to the elastic system in capacity for internal work, if real reduction in impact torque is to be realized. The rolling mill coupling of Figure 2 suggests that such is practical, and the torque-deflection curve of a typical steel grid coupling shown in Figure 3 confirms it.

Technically, resilience defines the potential energy required to produce the yield point stress and is therefore equal to the total volume under stress multiplied by the modulus of resilience, the latter being equal to

Figure 1 — Diagram gives torque deformation for a given value of shock energy.

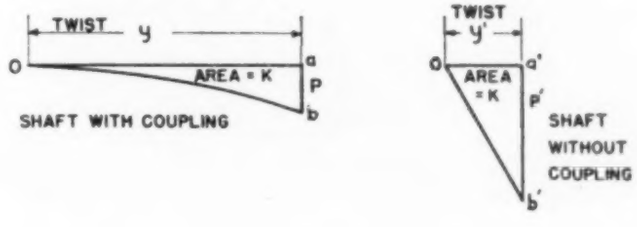


Figure 2 — The steel spring grid type coupling introduces a great deal of resilience in the system.

the stress squared divided by twice the modulus of elasticity when in tension.

The potential energy that can be stored in a coupling at the instant of impact will be determined to a large degree by the manner in which the loaded elements are put to work. When the grid design is based upon the principle of a continuous beam assuring uniformly stressed loops, very high capacity can be obtained, as indicated in the resiliency diagram of Figure 4. It presents a startling contrast with the fractional return of the single loop design shown alongside it.

Both designs employ hardened alloy steel having a modulus of resilience in tension close to 700 times that of cast iron. The difference in the areas of resilience is due to the fact that in the continuous grid, the major volume of material is subjected to the full stress.

VIBRATION ARREST

The bending stress in the steel spring grid beam is maintained at safe values even under heavy shock. This is accomplished by the unique character of the beam supports. The points of loading approach each other with increase in torque, thereby reducing beam length automatically. In addition to the protection obtained against breakage, the feature of a non-linear relationship between torque and deflection is achieved. The coupling becomes stiffer with each increment of load, a very practical characteristic for a shock absorbing element.

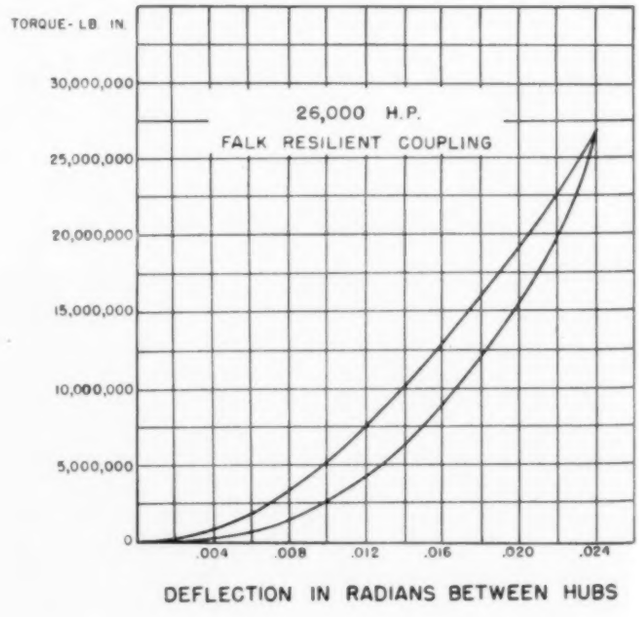
The change in the elastic length of the coupling may be sufficient to throw the natural period of vibration of the system out of phase with the frequency of a disturbing force when the cumulative loading under a condition approaching resonance develops. Critical speeds are not experienced as such in rolling mill practice, but a similar transient vibratory phenomenon is possible, as for instance, during slippage between roll and slab. In such cases, the rate of decay of the vibratory wave, or its logarithmic decrement as it is known in technical nomenclature, is influenced considerably.

This "die-away" of the vibration curve is greatly affected by friction or damping. Referring again to Figure 3, it will be observed that a considerable area lies between the ascending and descending torque-deflection curves. That this is hysteresis which will manifest itself in arresting vibration is quite obvious. Its source is in the action that takes place between grid and tooth as increasing values of torque are applied. Sliding as well as rolling of the rung over the tooth profile develops as the span of the beam supports shorten, and its enveloping wrap increases. The concave-convex nature of the contact has the incidental advantages of reducing contact stresses to very low values as well as providing the converging surfaces conducive to good lubrication.

ALINEMENT FUNCTION MUST BE PRESERVED

It should be emphasized that the storing of energy in the steel spring grids during application of shock does not interfere with double engagement function by which it corrects for misalinement. There are, however, two very important contributions from the elastic grid structure to the kinematics of the flexible coupling. First, the pitch is self-varying and will accommodate itself to pitch requirement arising from the elliptical

Figure 3 — The energy absorbed by the coupling is very appreciable as is shown by the torque-deformation diagram.



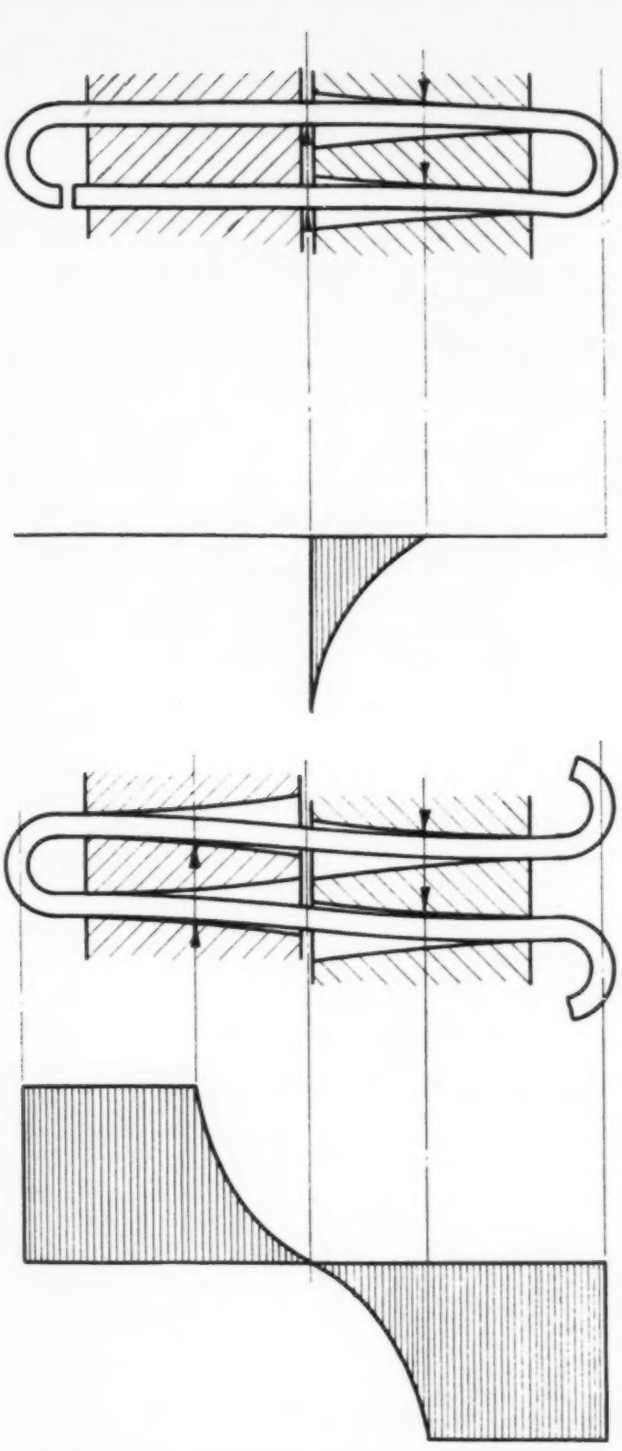


Figure 4 — The upper curve shows the resiliency diagram for a single loop or prong type coupling. The lower diagram shows the resiliency incorporated in a steel spring grid type coupling.

distortion under misalinement. Second, the concentrated bearing and corner loading that would otherwise limit contact to two pairs of teeth is completely eliminated.

The fact that the pitch of the rung can be changed with very little effort makes it practical to vary several of them sufficient to eliminate backlash, a desirable feature where the vibratory torque exceeds 100 per cent during any period of the operation.

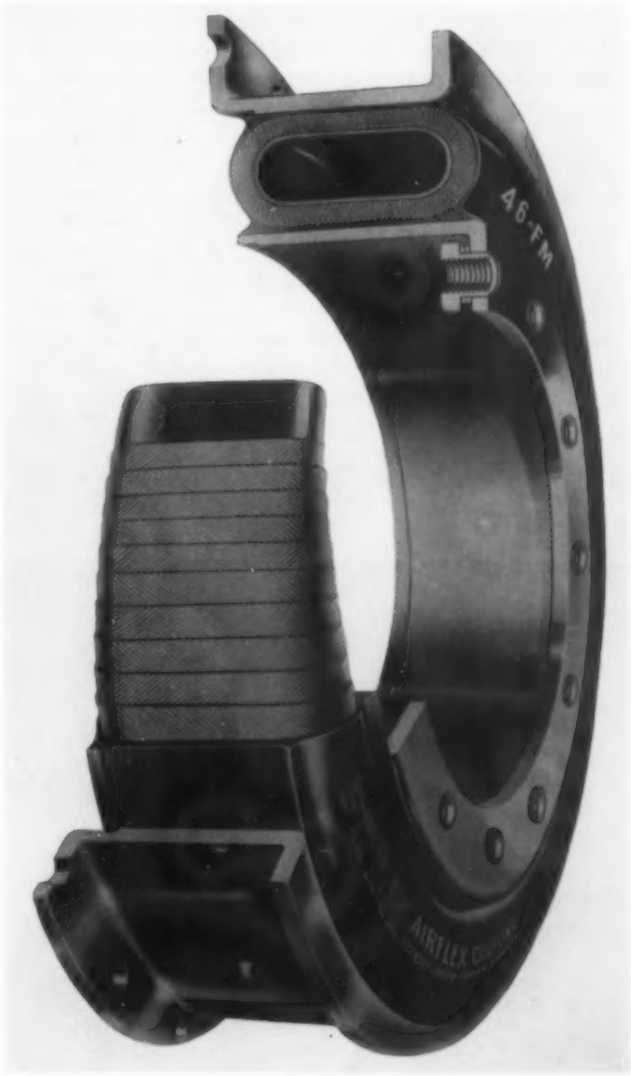
INFLATED GLAND COUPLING

A most interesting development of recent years is an inflated gland coupling, invented by Thomas L. Fawick. It consists of a molded rubber-cord gland vulcanized to inner and outer steel rims, and inflated with glycerin (or air). Load is transmitted through a multiple series of rubberized cords inclined to the drum peripheries, thus approaching the ideal of an infinite number of links. Figure 5 shows the construction features.

This design has already established itself as an excellent torsionally resilient coupling for service involving extreme shock. Because of its flanged construction, it is readily adaptable to flywheels of engines or compressors in which applications it does particularly well by virtue of its high dampening properties and the absence of backlash. Like the steel grid, its torque-deflection curve is non-linear.

Figure 6 shows this design in a coupling testing machine designed to apply any desired vibratory torque combinations. This coupling has endured millions of

Figure 5 — The construction features of the gland type coupling are shown in this cutaway view.



cycles of completely reversed torque at its full load rating without deterioration.

Applications in steel mills have been limited. Its success in other fields under very high shock invites further consideration in this industry.

OTHER DESIGNS OF RESILIENT COUPLINGS

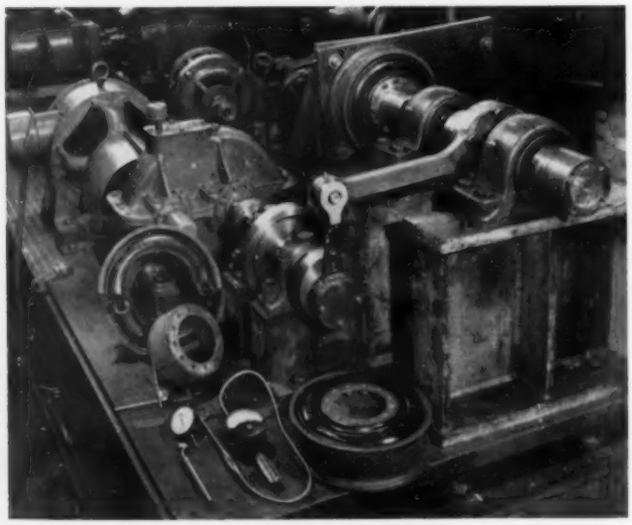
The number of couplings that may be classed as torsionally resilient is small and most of these are proprietary designs. Ordinary so-called flexible couplings have only limited resilience since the elasticity they do possess is employed mainly to facilitate operation under misalinement. Figure 7 illustrates a coupling manufactured in England, the resiliency diagram of which has already been examined. It will be noted that it is of the single acting type.

A continental pre-war design, known as the Voith-Maurer, is pictured in Figure 8. Compensatory movements under misalinement are all obtained through elasticity operating on the double engagement principle. The torque-deflection curve is a straight line which provides the explanation for the interlocking stops in the center plate. Since the stress range in the connecting elements is large, the resilience diagram is not good and potential energy capacity suffers accordingly.

The laminated leaf arrangement has been adopted in the single acting American design of Figure 9. It has a non-linear characteristic, some desirable damping as a consequence of leaf friction, but resilience is relatively low.

Figure 10 illustrates a coil spring resilient coupling that has had considerable application to engine drives. It operates on the flexible link single acting principle, and since all of the coil is subjected to a uniform shear stress, the resilience diagram is very good. The torque deflection characteristic is linear, so the coupling will close up suddenly under sufficient overload. Like most of the couplings described here, the coil coupling has had but limited steel mill application.

Figure 6 — Development of couplings was aided by a series of fatigue tests in a special machine designed to apply any desired combinations of torque.



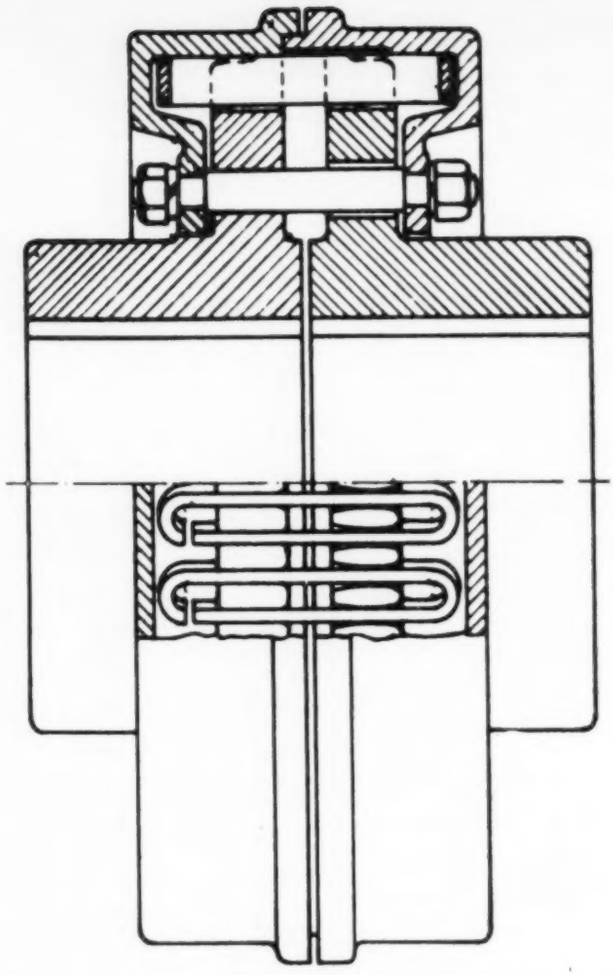


Figure 7 — The coupling shown is manufactured in England.

In the discussion of resilient couplings which follows, the author will limit himself to installations of his company's steel grid type, first because he can speak of these from first hand knowledge and secondly, because this is the only resilient design that has enjoyed any extensive steel mill application. Before proceeding, however, a reference to practice abroad is in order. Steel grid couplings are manufactured with certain variations under license on the continent as well as in England. Resilient couplings have been widely adapted in the steel mills of Europe.

One such design, illustrated in Figure 11, replaced a torsionally rigid coupling between the flywheel and the pinion housing of a 1500-hp, 3-high, 27½-in. strip mill in the Rhineland. The instantaneous shock loading was estimated at 9000 hp at 85 rpm. Failures of shafts, pinion housings and base plates were experienced until installation of the resilient coupling. From that time on, continuous operation was possible. An interesting provision for breakage is incorporated in the hub of the driven half. Under a sudden thrust of sufficient magnitude, the inner hub section will shear the location screws and move into the recess with the shaft extension affording the necessary relief.

Many similar instances of improved operation and elimination of breakage can be drawn from the American practice. A few have special significance in that

they may lead to some valid conclusions as to the magnitude of the reduction of torque that can be expected under shock when torsional coupling resilience is employed judiciously.

CONTINUOUS HOT MILL APPLICATION

The first of these is a continuous hot sheet mill, located in the Detroit area, consisting of a scale breaker and six four-high mills. The motors were connected to the input shafts of the gear units by pairs of piloted torsionally rigid couplings, the motor end of each equipped with shear pins.

The difficulties associated with the shearing of pins reached such proportions after the first ten months of operation that some remedial action was deemed advisable. The pins would offset an average of 0.020 in. in eight hours requiring replacement once every turn, in order to avoid complete fatigue shearing.

It was decided to make a test of a single torsionally resilient coupling applied at the reducer end of the Number 1 finishing stand, leaving the torsionally rigid shear pin coupling at the motor end intact. This stand was taking a 45 per cent reduction first pass with a fresh slab coming in about once a minute, accompanied by distinct shock.

Smoother operation followed upon the change. Maintenance was reduced to roughly one-twentieth, for no offsetting of pins took place until the 160-hour inspection, at which time it measured 0.015 in. Properly interpreted on an S-N diagram, a pretty fair approximation of the reduction in impact torque might have been obtained, or better yet the pin size could have been reduced until about 0.020 in. offset was obtained in an 8-hour interval; but there is rarely enough time for taking such data and when there is steel to be rolled, these questions remain academic.

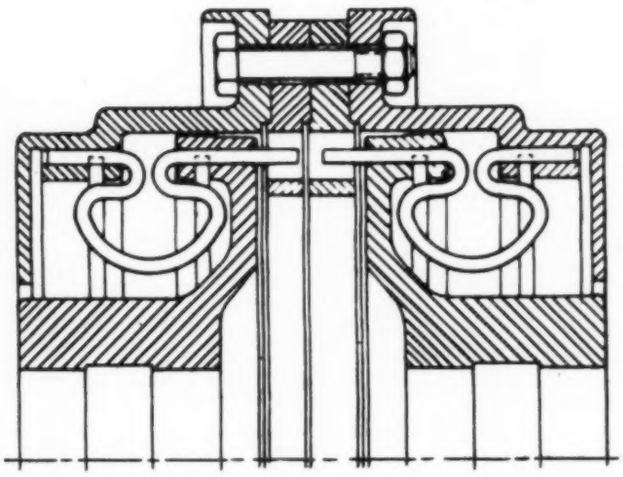


Figure 8 — This type coupling has a straight line torque-deflection curve.

The operators reasoned that if both couplings were resilient, the offset could be eliminated entirely, thus obviating the need for shear pins. A steel spring grid coupling was substituted at the motor end, minus the shear pin provision. The new coupling is pictured in Figure 12. Following this, resilient couplings were applied to all other stands and the trouble became history.

SHEAR PIN PROTECTION

While it is true that shear pins have been a source of annoyance in many applications, the difficulties can be attributed in considerable degree to the rigid system in which they were required to operate, and to their proximity to the high coupling masses. This induces fatigue under the normal recurrent peaks, defeating their intended purpose, namely to provide a fuse in the event of cobbles or mill accidents that imperil the equipment. Pin fatigue is not encountered in resilient shear pin coupling operation. Figure 13 shows the design features of a low speed tandem coupling that combines properly designed shear pins with maximum torsional resilience.

A low inertia piloted assembly of resilient couplings is shown in Figure 14. The shaft is a hollow tube and the WR^2 of the entire structure is very low. The left hand hub contains the shear pin assembly. Painstaking effort was expended in the design and as usual the results were in proportion.

CONTROLLED TORQUE SLIP FOR CYCLIC PEAKS

Where repetitive cyclic peaks attain values that induce fatigue, some means other than shear pins must be found by which continued safe operation will be assured. Ordinarily, the resilient coupling contributes the necessary relief. In lieu of this, we could consider a slip coupling with the normal pressures so controlled that only fractional movement would take place at the instant of impact, and driving contact reestablished immediately thereafter. This feature could be combined with torsional resilience as in the controlled torque steel grid coupling shown in Figure 15. The occasion to make this application developed as a consequence of periodic fatigue failures on the high speed reducer shaft of an 84-in. four-high temper pass mill. The trouble was not caused by accidents, but apparently by the repeated shocks of the heavy back-up rolls dropping down on the work rolls at the conclusion of each pass.

After the original rigid coupling was replaced with the resilient torque controlled coupling, several test runs were made during which the proper adjustment was determined. A slip increment of $\frac{1}{8}$ in. per pass, measured on the periphery of the friction ring was settled on and this has proven satisfactory for no subsequent failures have taken place.

The extent of the contribution of resilience in this instance might be determined if provision were made for

Figure 9 — Shown here is the laminated leaf coupling design.

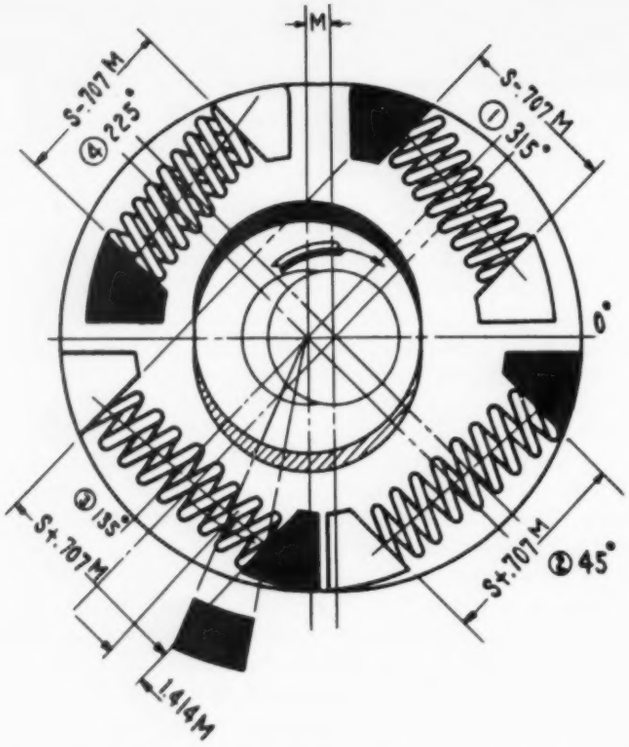


Figure 10 — The coil spring type coupling is not used much in steel plant applications.

momentarily locking it out and measuring the increase in pressure on the friction discs required to hold the slip increment at ⅛ in. This, however, has not been attempted.

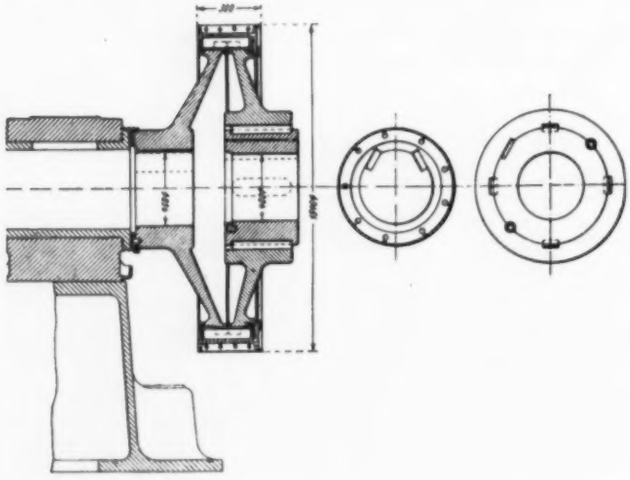
INFLUENCE OF RESILIENCE ON BLOOMING MILL LOADS

The reduction of torque that can be obtained through torsional resilience has been computed in a theoretical analysis of a 35-in. blooming mill located in Ohio. The mill shown in Figure 16 reverses 6 times per minute at a speed of 100 rpm and is driven by a special reversing mill motor having a maximum rated torque capacity of 1,200,000 lb ft. It was estimated from the strength of certain repeatedly fractured elements that the impact torque was 1,600,000 lb ft or 19,200,000 lb in.

The down time reached such proportions that it was decided to investigate the relief that might be expected from a replacement of the torsionally rigid leading coupling with one of the resilient shock absorbing type. The theoretical analysis follows:

The potential strain energy must first be determined and for simplicity all shaft deflections are reduced to a common equivalent diameter which, in this case, was conveniently selected as 17.92 in. The equivalent shaft length for each section was computed for the 17.92 in. diameter and found to be 220 in. from pinion to center of rolls, and 39 in. from center of armature to center of pinion.

Figure 11 — Installation of the coupling shown eliminated a number of troubles on a 27½-in. strip mill in a German steel plant.



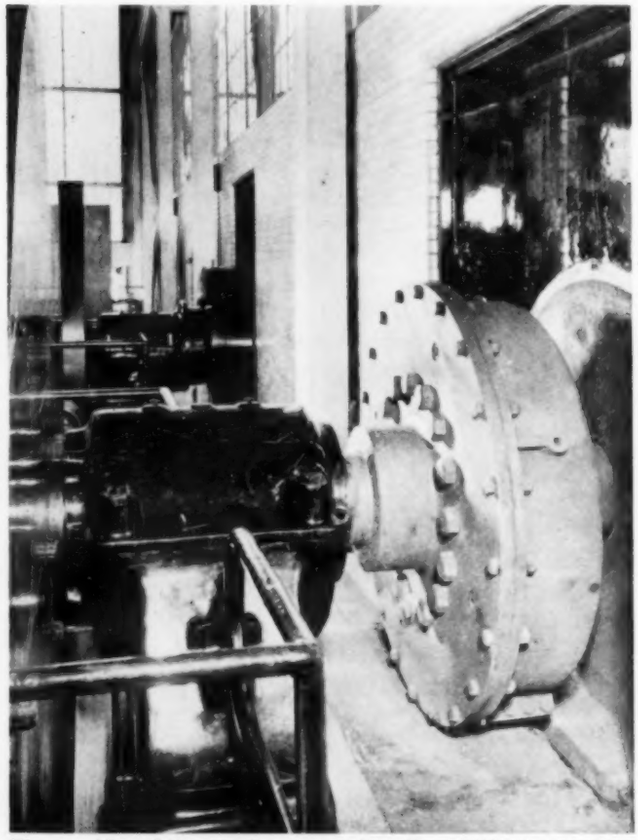


Figure 12 — After trying a torsionally resilient coupling on a test run on this hot sheet mill, similar couplings were applied to all the other stands as a result of the test.

The polar moment of inertia has a value

$$J = \frac{\pi d^4}{32} = \frac{\pi \times 17.92^4}{32} = 10.120 \text{ in.}^4$$

The potential energy for the 39-in. length of shaft was found to be

$$K = \frac{T^2 L}{2E_s J} = \frac{19{,}200{,}000^2 \times 39}{2 \times 12{,}000{,}000 \times 10{,}120} = 59{,}100 \text{ in. lb}$$

For the 220 in. equivalent length, one-half the torque is transmitted to each section, so

$$K = \frac{9{,}600{,}000^2 \times 220}{2 \times 12{,}000{,}000 \times 10{,}120} = 83{,}500 \text{ in. lb}$$

The total potential energy of the system with a non-resilient coupling is 59,100 plus 83,500 plus 83,500

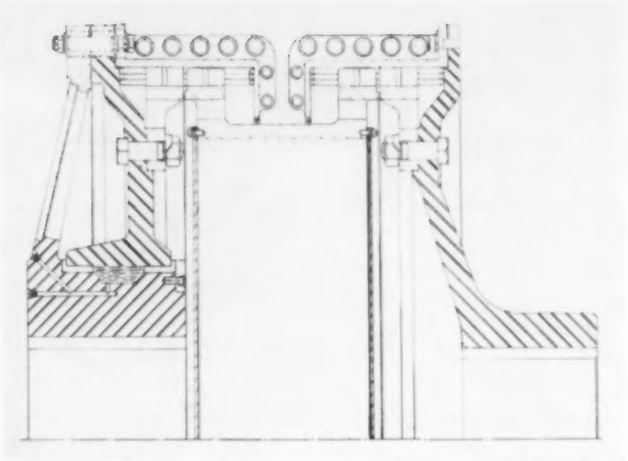


Figure 13 — It is possible to combine shear pins with good torsional resilience.

equals 226,100 in. lb. This is also the value of the applied energy.

In order to determine the load to be expected with the resilient coupling, decreasing values of torque must be taken and the potential energy computed by the equation:

$K = \frac{T_2^2 L}{2E_s J}$ for the shafts. The new torque value is obtained when the potential energy equals that of the applied energy previously computed. The potential energy for the coupling is found from the test curve shown in Figure 17. When the correct value of the torque is determined, the sum of the potential energies of the component parts must total 226,100 in. lb as before. This torque is found to be 14,300,000 in. lb. The potential energy of the various parts follows:

For 21.37 in. coupling extension:

$$K = \frac{T^2 L}{2E_s J} = \frac{14{,}300{,}000^2 \times 21.37}{2 \times 12{,}000{,}000 \times 10{,}120} = 18{,}000 \text{ in. lb}$$

For 39 in. shaft:

$$K = \frac{14{,}300{,}000^2 \times 39}{2 \times 12{,}000{,}000 \times 10{,}120} = 32{,}900 \text{ in. lb}$$

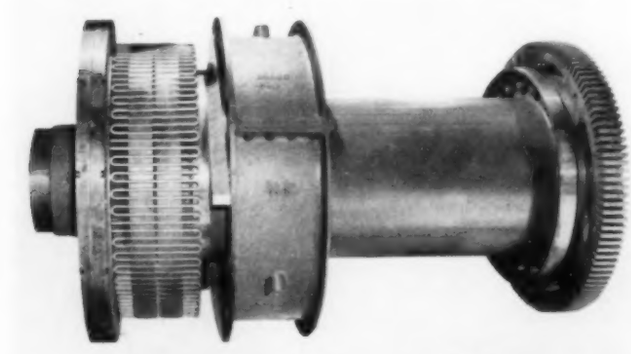
For 220 in. shaft:

$$K = \frac{7{,}150{,}000^2 \times 220}{2 \times 12{,}000{,}000 \times 10{,}120} = 46{,}300 \text{ in. lb each}$$

From the coupling curve (Figure 17) for a 14,300,000 lb in. torque

$$K^1 = 81{,}900 \text{ in. lb}$$

Figure 14 — The design shown featured a low moment of inertia.



The potential energy of these totals 225,400 in. lb—check.

The introduction of the 26,000-hp resilient coupling was responsible for a reduction in peak torque from 19,200,000 to 14,300,000 or 4,900,000 lb in. less than with the rigid coupling.

The tooth pressure was reduced from 9,960 lb per in. of face to 7,430 lb per in. of face.

The resilient coupling was purchased and put into service, after which it was possible to operate continuously without the costly breakdowns previously encountered. Production increased between 2,000 and 5,000 tons per month.

The energy diagram, Figure 18, proves that the amount of energy stored in a resilient coupling during shock application is relatively small, even though a large reduction in torque is effected. The shaded area indicates the energy which has been absorbed by the coupling during impact and subsequently released in the form of useful work in the rolling operation.

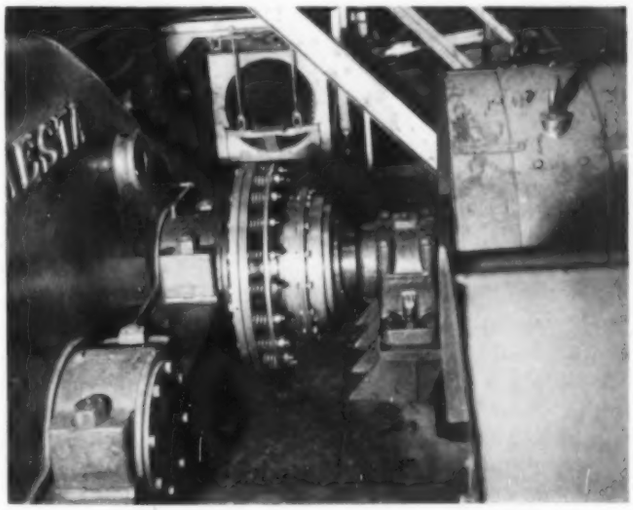


Figure 15 — Application shown is on the high speed reducer shaft of an 84-in., 4-high temper pass mill.

FIELD TEST OF MEASURED TORQUE

Refinements in testing equipment and services now available make it possible to ascertain with accuracy the torque at every point in the rolling mill cycle. By successive tests of a mill with rigid and with resilient couplings, quantitative determination of torque reduction is permitted.

Such a test was recently completed on the No. 4 stand of a 3000-hp hot strip mill located in southern Ohio. The test couplings, located between the motor and the high speed shaft of the reducer, were of a combination shear pin type, one torsionally rigid and the other torsionally resilient. The rolling mill equipment was not disturbed between tests and every effort was made to obtain the closest possible uniformity in operating speeds, gage, temperature, head ends, etc.

To assure the desired accuracy of instrumentation and to eliminate any possible bias, the responsibility for tests was turned over to a General Electric Co. staff of technicians. The instruments employed were an electrical recording oscillograph, a torque meter, an

TABLE I - COMPARATIVE TORQUES

Pair No.	Test No.		Material	Rolled	Lead shape		Torque values - in.lb. Multiply by 10^5				VALUES ADJUSTED ON WIDTH BASIS				
							Impact		Rebound		Amount added or deduced to resilient coupling	Torque values - in.lb. Multiply by 10^5			
												Impact		Rebound	
	Gear type	Resilient	Gear type	Resilient	Gear type	Resilient	Gear type	Resilient	Gear type	Resilient		Gear type	Resilient	Gear type	Resilient
1	15	32-B	RL2 0.100x66.5	JL 0.100x67			33.0	26.9	7.5	6.5	Deduct 0.8%	33.0	26.69	7.5	6.46
2	13	29	JL2 0.100x66.5	JL 0.100x65.5			31	24.5	6.25	5.2	Add 1.5%	31.0	24.87	6.25	5.28
3	4	28	L2 0.117x57	L 0.117x53			31.5	17.35	5.0	5.2	Add 7%	31.5	18.56	5.0	5.56
4	14 [2]	31	JL2 0.100x66.5	JL 0.100x67			21.5	21.14	13.25	12.4	Deduct 8%	21.5	20.97	13.25	12.3
5	17	46-B	RL 0.090x68	RL 0.090x68			34.0	23.0	9.75	6.4		34.0	23.0	9.75	6.4
6	22 [1]	43	RL 0.095x76	RL 0.095x72.5			36.0	23.0	15.75	11.8	Add 4.5%	36.0	24.04	15.75	12.33
7	18	40	RL 0.095x69.5	MLKO.095x71			35.25	22.9	7.5	7.8	Deduct 2%	35.25	22.44	7.50	7.64
8	16 [1]	30-A	RL 0.100x66.5	JL 0.100x65.5			33	23.3	10.0	5.3	Add 1.5%	33.0	23.65	10.0	5.38
9	23	45	EMJ 0.090x67	RL 0.090x68			38.0	23.6	8.75	9.7	Deduct 1.5%	38.0	23.25	8.75	9.55
10	21	44-B	RL 0.095x76	RL 0.095x72.5			39.0	22.5	14.5	11.1	Add 4.5%	39.0	23.51	14.5	11.6
Average Torques							33.23	22.82	9.83	8.14		33.23	23.1	9.83	8.25

Maximum torque — Resilient - 30.49 per cent lower
Rebound torque — Resilient - 16.1 per cent lower
Maximum minus rebound torque — Resilient - 27.2 per cent lower

electrical tachometer driven from the free end of the motor, a delco distributor with cam marking each revolution of the mill roll, motor current meter attached to the oscillograph and photographing meters. The key instrument is the torque meter which makes possible the measurement of the difference in twist between rings mounted on the lead spindle. The torque is calculated from the recorded value of total deflection read on the oscillograph screen.

When the strip impacts against the rolls upon entry, it excites the natural frequency of the revolving ele-

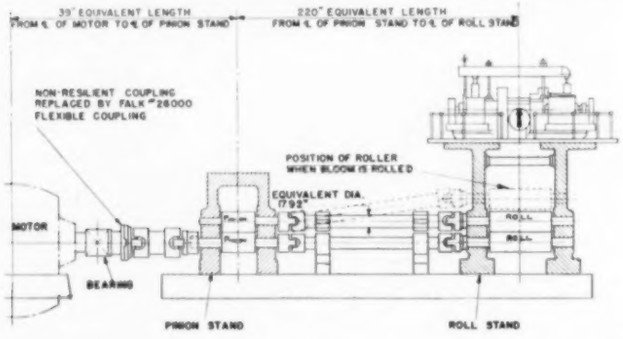


Figure 16 — Down-time on the 35-in., reversing blooming mill shown was reduced through the installation of a resilient coupling.

ments of the mill and this vibration is recorded as an impact surge with die-away curve characteristic as can be noted from the oscillograph pictures shown in Figures 19 and 20. Several impact surges follow the initial one varying in time and magnitude, but influenced considerably by the damping present. It will be observed that the decay progresses at a higher rate with the resilient coupling and that the corresponding amplitude of the secondary surges is much lower. The sources of this property in the steel grid coupling has already been explained.

Table I summarizes the data pertaining to impact

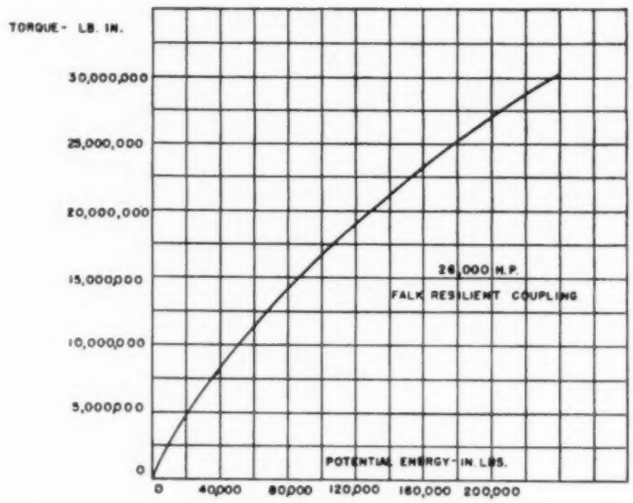
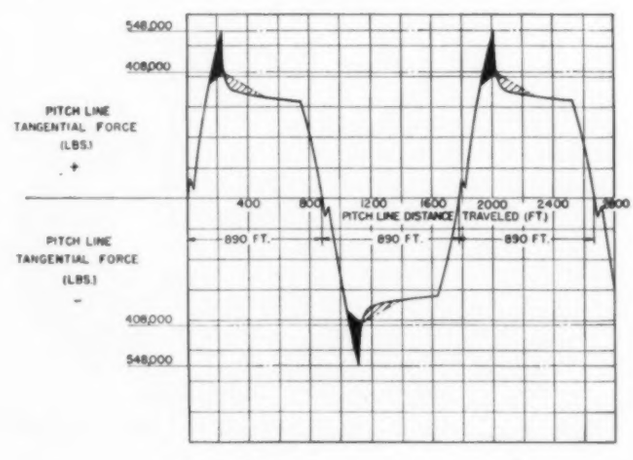


Figure 17 — Test curve giving potential energy for resilient coupling for blooming mill is given here.

Figure 18 — Energy diagram of resilient coupling.



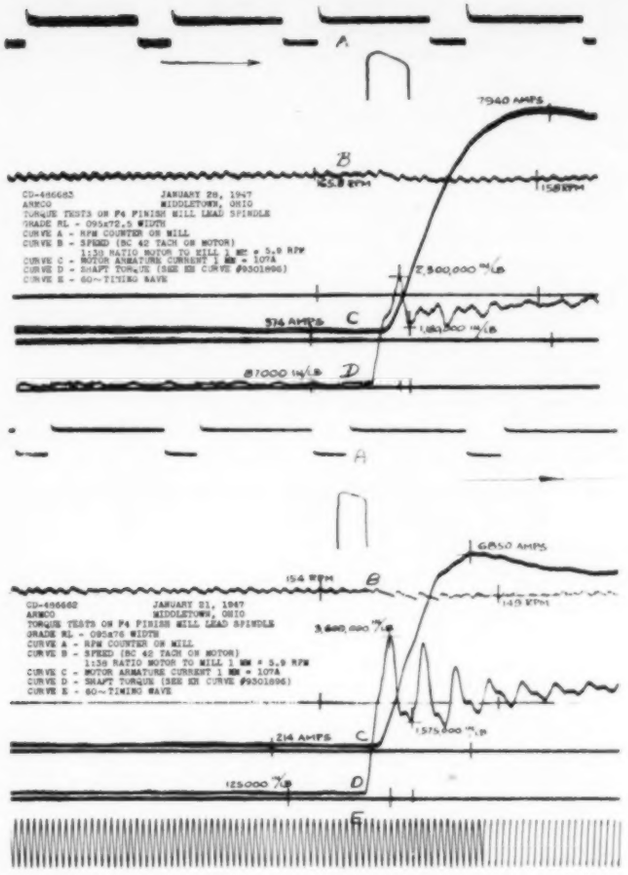

7940 AMPS
B
CD-486663 JANUARY 28, 1947
AMMCO MIDDLETOWN, OHIO
TORQUE TESTS ON F4 FINISH MILL LEAD SPINDLE
GRADE RL - 095x72.5 WIDTH
CURVE A - RPM COUNTER ON MILL
CURVE B - SPEED (SC 42 TACH ON MOTOR)
1:30 RATIO MOTOR TO MILL 1 RPM = 5.9 RPM
CURVE C - MOTOR ARMATURE CURRENT 1 MM = 107A
CURVE D - SHAFT TORQUE (SEE KH CURVE #9301896)
CURVE E - 60~ TIMING WAVE
574 AMPS
C
D
A
6850 AMPS
154 RPM
B
CD-486662 JANUARY 21, 1947
AMMCO MIDDLETOWN, OHIO
TORQUE TESTS ON F4 FINISH MILL LEAD SPINDLE
GRADE RL - 095x76 WIDTH
CURVE A - RPM COUNTER ON MILL
CURVE B - SPEED (SC 42 TACH ON MOTOR)
1:30 RATIO MOTOR TO MILL 1 RPM = 5.9 RPM
CURVE C - MOTOR ARMATURE CURRENT 1 MM = 107A
CURVE D - SHAFT TORQUE (SEE KH CURVE #9301896)
CURVE E - 60~ TIMING WAVE
214 AMPS
C
D
E

Figure 19 — Upper curve gives field test data for resilient type coupling and lower curve gives similar data for gear type coupling.

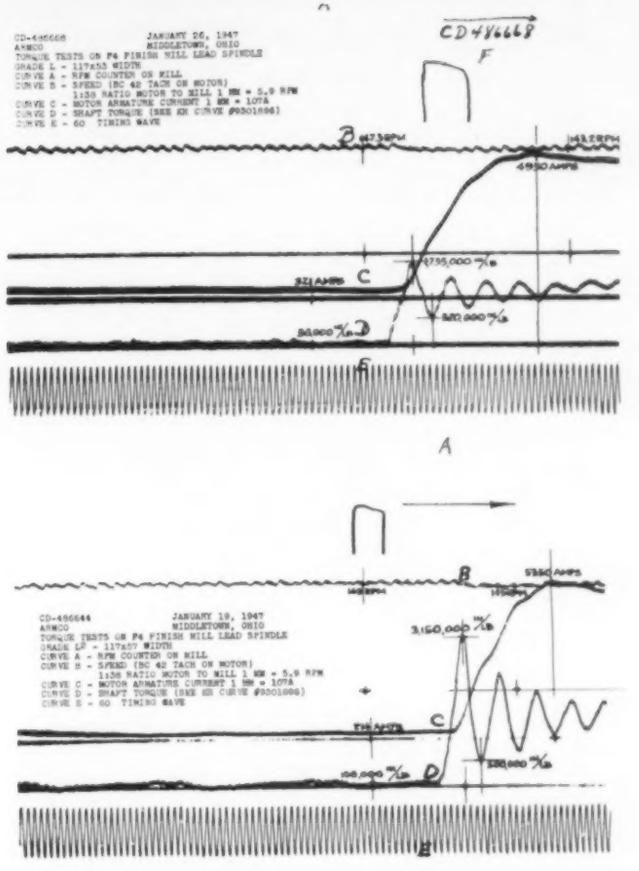

CD-486666 JANUARY 26, 1947
AMMCO MIDDLETOWN, OHIO
TORQUE TESTS ON F4 FINISH MILL LEAD SPINDLE
GRADE L - 117x55 WIDTH
CURVE A - RPM COUNTER ON MILL
CURVE B - SPEED (SC 42 TACH ON MOTOR)
1:30 RATIO MOTOR TO MILL 1 RPM = 5.9 RPM
CURVE C - MOTOR ARMATURE CURRENT 1 MM = 107A
CURVE D - SHAFT TORQUE (SEE KH CURVE #9301896)
CURVE E - 60 TIMING WAVE
CD 476668
F
B
4950 AMPS
C
D
E
A
CD-486644 JANUARY 19, 1947
AMMCO MIDDLETOWN, OHIO
TORQUE TESTS ON F4 FINISH MILL LEAD SPINDLE
GRADE LP - 117x57 WIDTH
CURVE A - RPM COUNTER ON MILL
CURVE B - SPEED (SC 42 TACH ON MOTOR)
1:30 RATIO MOTOR TO MILL 1 RPM = 5.9 RPM
CURVE C - MOTOR ARMATURE CURRENT 1 MM = 107A
CURVE D - SHAFT TORQUE (SEE KH CURVE #9301896)
CURVE E - 60 TIMING WAVE
B
C
D
E

Figure 20 — Data for resilient type coupling is given in upper curve and data for gear type coupling is given in lower curve. Values are greater on lower curve than on upper curve.

and rebound torque values for ten pair of comparable tests for rigid and resilient couplings. Care was exercised to obtain as nearly identical conditions of temperature, ductility, line speed, shape of forward end of the strip, volume of metal passed and reduction. An average of the ten sets indicates that the impact torque with our steel grid spring coupling is 30 per cent less than with the torsionally rigid dental coupling.

This reduction in torque is obtained by virtue of the principle of dynamics stated early in the paper. The kinetic energy in the work of rolling is of the same value in both tests, so the potential energy stored momentarily in the two systems is identical. When the resilience is increased, the torque must be decreased in order to balance the equation. The torque meter measures this reduced impact torque directly.

It will be noted that Table I contains a double column headed "reboundtorque," the significance of which ought to be explained. The potential energy stored in the system is a maximum at the instant when the impact torque as revealed by the oscillograph is the highest. This potential spring energy has to be translated back into kinetic energy when unwinding takes place. The reversed flow proceeds until the minimum torque value is reached, this being somewhat less than the average torque. It is known as the "rebound torque."

The difference between the initial peak torque and the rebound torque is known technically by the rather forbidding appellation "initial rebound double amplitude torque." Its value is determined by such factors as the magnitude of the initial impact torque, supplementary shock loads when unwinding and the damping contributed by the coupling, roll friction, bearings, etc.

The data obtained from the oscillographs of the ten matched pairs averaged 36 per cent less for this total reactionary torque value when operating with the resilient coupling.

The maximum impact torque reduction of 30 per cent is related to the maximum stress imposed on the load transmitting elements, whereas the 36 per cent reduction in initial rebound double amplitude torque is related to the reduction in the range of the imposed stress.

CONCLUSION

The torque produced on a rolling mill system during release of reactionary shock load energy is dependent upon the resilience of the total train. This may be influenced in a large measure by the capacity of a torsionally resilient coupling. When properly designed, such couplings will be effective in materially reducing impact torque as well as arresting undue vibration. The phenomenon is mathematically determinate and expected improvements can be computed with a fair degree of accuracy where all the factors are known. The load reduction on any actual installation can be measured when proper instruments are available. In the test reported herein, the impact torque was reduced 30 per cent with a resilient coupling. More steel was rolled in every case.

DISCUSSION

PRESENTED BY

JOSEPH A. MARLAND, Sales Manager, W. A. Jones Foundry & Machine Co., Chicago, Ill.

WALTER P. SCHMITTER, Chief Engineer, The Falk Corp., Milwaukee, Wis.

Joseph A. Marland: I hesitate to ask a question on this because I had hoped that some of the men, with practical operating experience, would ask some question about the significance of this graphic and mathematical data as to what actually is beneficial, in practice, from the use of a torsionally resilient, or torsionally adjustable, coupling in replacing the torsionally rigid coupling. Also, where shear pins are employed in conjunction with such gear-type couplings, just how do they compare in practice grids, in terms of the life of the spring because that is where we have been disappointed bitterly? I have found that the whole story is not told in just photographs because a time element is represented as to how long these spring grids will last as compared with the shear pin which is non-resilient and cuts out fast.

Walter P. Schmitter: I tried to show, with four different examples, what the advantage was for resilience in a coupling applied to a system subjected to shock. The question that has been asked, I think, refers to the kinematics of the coupling and its influence on life expectancy.

The advantage of resiliency in any coupling, in so far as its functional operation is concerned during misalinement, is in alleviating the load concentrations on the coupling itself and the reactions on the shafts and bearings. We have, in single-acting couplings, a cyclic disturbance which arises from the fact that all of the forces must take place in a plane normal to the shaft centers. We have, in double-acting couplings, an elliptical distortion which is mathematically determinate, and which sets down a requirement for a change in pitch; and, with non-rigid couplings of the double-acting type, such a change in pitch is not possible. Therefore, we have only two pairs of teeth carrying the load under a misalinement in double acting couplings, unless they contain some device for splitting the angular error such as we have on certain of the patented universal joints, or on a flexible pitch grid.

Now, reference was made to what life we might expect of the resilient-grid elements. I can assure you that there is no product manufactured by us in which the replacements are lower than in the steel grid couplings. You must take my word for that. We are of course interested in the number of failures that are occurring in any part of its equipment, as is any other company. If the life of the grid element was not comparable to that of the rest of our equipment, we would very quickly change the rating, but I am quite sure that the ratings are too conservative at the present time, and I was discussing that very matter with our coupling sales manager on our trip down here. I hope that I have answered your question; if not, I would be glad to go into further detail.

Joseph A. Marland: My experience on this was very sharply impressed upon me because we went through the very picture you analyzed here. We did not make a selection of couplings, but they were made for us by someone in authority at the resilient coupling manufacturer's office. After use of that selection, for the summer period and extending through the fall, which was on a satisfactory plane, we had no complaints until the arrival of cold weather. Of course the starting loads on cold mornings were higher, but that is just when the spring grid snapped and we tried that again and again with a number of spring replacements. We found that by keeping the room air around the coupling warm so that the power loaded spring grid temperature was not so critical, we enjoyed fair performance. Later our management decided that was not the way they wanted it done and we replaced it with the radially-extending spring leaf type coupling, which is known as the cantilever. That type had the same basic limitation during cold weather, when with the spring rigidity and the higher critical stresses within the cold spring steel—high breakage occurred.

May I just say, I appreciate the fact that you have given this thorough study and I want to sincerely compliment you on this thoroughness of presentation because you do include the several types of torsionally variable devices, both the inflated gland features and the frictional type of clutch which, to my mind, approaches the problem in a sound and dependable way. You permit, there, the release of the peak energy which will not only have a small arc, such a small arc in terms of rotation as to be only in seconds or in minutes of arc, but you release that peak torque in hundreds of degrees or in hundreds of revolutions of shaft to dissipate that shock. We found, eventually, that such an approach to the problem, as you have indicated there, would be the apparent solution but, for practical reasons of first cost and maintenance costs, the type of coupling which did not compare so favorably in your paper, was the type which we selected and which has been giving us completely satisfactory results; that is the gear type. We do not manufacture gear type couplings. I am interested in equipment that must have some kind of dependable and safe coupling connection, and that is my reason in bringing up the above point.

Walter P. Schmitter: Of course, there are cases of trouble. I do not think there is a manufacturer of equipment in the room, who has not, at some time or other, experienced difficulty in the selection of the sizes of couplings or some other piece of equipment. If I were talking about application engineering, I would certainly want to answer that in greater detail. However, this paper has been directed toward the dynamics of the mass elastic system under shock and the influence exerted by the torsionally resilient coupling. I did point out the advantages it has under such conditions.

We, of course, do not have all the advantages. You sell a number of couplings since you have the advantage of price. There are times when, particularly in the larger sizes, the greater expenditure for resilient coupling of this kind is not justified. That is when you go out and get the job.

When we have an instance of real difficulty, and we are able to demonstrate, as I have tried to demonstrate today, that it is possible to affect a reduction in the peak torque obtained and a subsequent increase in mill life, then we are apt to fare pretty well.

TECHNICAL PROGRAM OF THE

American Iron and Steel Institute

. . . . in reviewing problems of iron and steel production, leading operators of the steel industry, at the fifty-eighth general meeting of the American Iron and Steel Institute held in New York City on May 24 and 25, presented a number of interesting papers . . . . special panels were held on Raw Materials and Operations, Electronic Controls, Testing and Inspection and Shipping Problems . . . . because of their value to the industry, some of the papers are abstracted here . . . .

"MATERIALS HANDLING IN THE STEEL INDUSTRY"

by W. G. NICHOL, Manager, and W. N. FLANAGAN, Fuel and Furnace Engineer, Methods Engineering Bureau, Carnegie-Illinois Steel Corp., Pittsburgh, Pa.

The complete paper as written is long enough and detailed enough to constitute a text book on the problem of materials handling in the steel industry. Beginning with the production of the raw materials, the authors describe practically all the steps required for the production of the finished steel product and the effect and influence of materials handling on each step. Present methods are described and some of the latest developments and improvements are given in detail. Among some of the high points from the paper are the following excerpts:

▲ IN recent years it has been generally recognized that improvements in materials handling techniques offer one of the most effective means of bringing about operating cost reductions. The return to normal competition and the exceedingly high cost of replacing the marginal plant facilities now in operation have forced the steel industry to seek ways of utilizing existing equipment to the best possible advantage. The application of modern handling methods is certainly one of the major areas in which worthwhile cost improvements can be achieved.

The attainment of the objective of improved handling costs is not an accomplishment to which only the trained technician can contribute. Much of the progress that already has been made is the result of ideas conceived and put into effect by operating personnel. The interest and cooperation of the front line operating employee, with his constant association with handling problems, is an essential part of any program designed for modernizing handling practices.

What does the term "materials handling" mean to the steel industry? This question usually brings to mind a picture of a fork lift tractor handling palletized materials, a mobile crane unloading scrap from a freight car, or some similar operation. It rarely occurs to us immediately that from 60 per cent to 90 per cent of all the direct labor man hours involved in making steel are related, either directly or indirectly, to some form of materials handling.

The magnitude of the problem of handling only raw materials is well illustrated by the following statistics from American Iron and Steel Institute: "Raw material requirements for a full year of 96,000,000 tons of ingots and 70,000,000 tons of pig iron are approximately 130,000,000 net tons of iron ore, 50,000,000 tons of scrap, 111,500,000 tons of coal, 1,546,000 tons of manganese ore, 634,000 tons of chrome ore, 144,000 tons of metallic nickel, and large quantities of fuel oil and natural gas equivalent to another 16,000,000 tons of coal. After these materials are received in the steel plant they are rehandled many times in the various manufacturing processes, and in the transfer from one operation to another.

Unloading from ships and barges by means of bridges and towers is becoming more efficient through improved design. Rope operation equipment is being built with larger bucket capacity and higher travel speed. The use of a shuttle boom eliminates the necessity for the lift type apron for clearing ship superstructures. This type of installation provides greater flexibility than the use of conveyor sections which can be lowered into the hold of a vessel. A recently installed coal tower for river barge unloading has a free digging capacity of 800 tons per hour. The net capacity is 550 tons per hour, including time for clean up and moving barges.

Hopper cars are provided with car bottom doors which permit the coal to be dropped through the track trestle to a pit, or to a bin, which feeds a conveyor. Frequently, all of the coal will not flow freely out of the cars by force of gravity alone. Several types of car shakeout devices which agitate the car have been developed for use at the unloading point. These machines have proven to be very helpful in facilitating unloading operations.

Rotary car dumpers are being used extensively to unload coal cars, particularly in those cases where the bulk of the coal is shipped in gondola cars. The modern

car dumper will handle from 15 to 20 cars per hour with low man hour usage and minimum cost.

One of the difficult problems encountered in those localities where extremely cold weather is experienced, is the unloading of frozen cars of coal and other materials.

What appears to be a very effective installation for open-air thawing was recently completed at a western steel plant. Open topped refractory thawing boxes were constructed between the rails of the unloading track. The tops of the boxes are level with the bottom of the rails. The combustion chamber of each box, which is about four feet by three feet by 18 inches deep, is heated by coke oven gas. Gas burners are located on two sides of the chamber. The boxes are spaced uniformly along the length of track and the installation described could handle about five cars simultaneously. Although thawing time varied with the condition of the cars, the average holding time amounted to about 10 minutes. The refractory boxes are allowed to become hot before the cars are switched into position. Since the thawing is done by radiation rather than direct flame, very little damage to the cars was indicated.

Coke plants designed to supply the coke requirements of a single, adjacent steel producing unit are generally laid out in such a manner that coke can be delivered directly to blast furnace storage bins by belt conveyors. The larger coke plants, that supply more than one steel works, ship the bulk of the product by means of railroad hopper cars.

The amount of labor required in a coke plant for yard and track cleanup is somewhat proportional to the size of the plant. In a large plant this type of work consumes many man hours. The removal of coal and coke car spillage from railroad tracks is still being done in many cases by manual labor. There are several recently developed mechanized devices which have been used successfully for this type of work.

One of the major railroads, for several years operated a powered rotary brush sweeper which removes cinder and other debris from trunk lines at the rate of from three to four miles per hour. The brushes sweep the material onto a conveyor system which moves it to several gondola cars attached to the sweeping unit. This machine does an excellent job of cleaning, both between the rails, and to the outside of the ties, with a very low expenditure of man hours. The original cost of this equipment is high, and the average plant would hardly need a machine of this capacity, but as a service item supplied to steel plants by the railroads there are excellent possibilities for labor economies.

Another track cleanup device recently installed for steel plant service is a specially constructed scoop used on a conventional tractor. The scoop is designed with a deep groove which permits it to ride on the rail head, with the tractor straddling the rail. One-half the area inside the rails and the portion between the outside of the rail and the end of the ties are cleaned in one pass. The other half of the track is cleaned on the return trip.

In connection with the production of ammonium sulphate, large quantities of pebbled lime are used by the coal chemicals division. The lime is received in bulk form in boxcars and the unloading of these cars by manual methods presents a difficult and disagreeable problem.

The installation of vacuum conveyor systems for unloading lime has proved to be an effective solution to the problem.

Most plants must deliver coke to the blast furnace bins by railroad cars. This is because of nonintegration or excessive distance.

A belt conveyor is the most economical means of coke transportation on account of minimizing labor and degradation of the material.

When possible, the trend is toward delivery of the coke directly from the coke works to the blast furnace bins. Such an arrangement eliminates the need for locomotives on the trestle and the handling of empty cars and reduces coke breakage. However, in case of breakdown, trackage for coke delivery by conventional cars is provided. The problem of freezing is at a minimum in the case of coke.

The advantages are balanced by the need for surge bins or storage to take care of the variation between coke production and consumption. Extra large bins at the coke plant screening stations are essential and larger or more furnace bins are desirable, as well as a control for rapidly changing the speed of the conveyor.

SCRAP

The scrap produced by the rolling mills is most economically handled by loading directly into open hearth charging boxes at the mill—or at least into large containers. This minimizes delay of railroad cars or auto truck trailers.

Charging boxes up to 44 cu ft are now in use, while a few years ago 17 cu ft boxes were accepted in many large open hearths. The additional weight is compensated partially by the use of lighter weight welded cars.

A new 10-ton charging machine is equipped with new features for greater ease and speed in the handling of charging boxes. This ram is hydraulically operated. The conventional peel head and locking pin have been replaced by hydraulically operated jaws which grip the end of the charging boxes while the peel is being moved forward. This feature reduces the number of motions required to pick up a charging box, deliver it through the furnace door, and return the box to the charging boxcar. The use of the hydraulically operated jaws permits the use of simpler and less costly charging boxes.

A suggested means of further speeding up the operation is to copy from the elevator engineers the electric eye and microspotting device by having a beam at each door do the final adjusting as to position. The use of a variable voltage system will not only make operation easier but will reduce shock and maintenance.

PREPARING PRODUCTS FOR SHIPMENT

One form of warehouse work that consumes a major portion of available man hours, particularly on narrow strip and skelp coils, and small bars and sections, is securing the unit bundles by ties of wire or band. These unit loads are usually removed from production lines

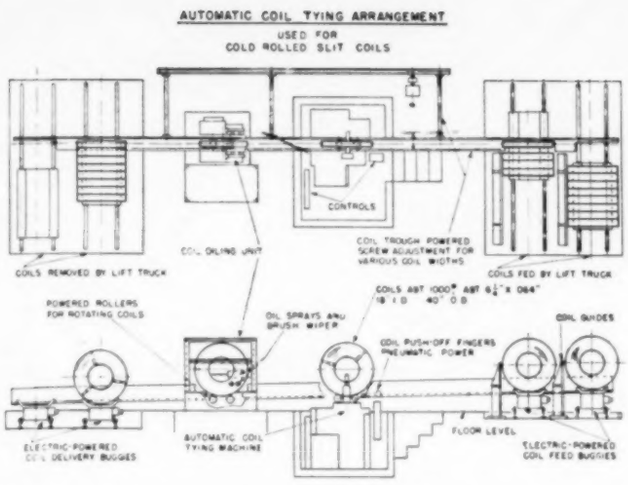


Figure 1 — The automatic coil tying equipment works very effectively and reduces operating costs.

and secured with ties by means of manually operated tensioning and cutoff machines. Recently developed semiautomatic and some fully automatic strapping machines for tying coils have been installed with very satisfactory results. One of the machines, which was put into service more than two years ago, performs the entire operation of banding, tensioning and sealing automatically (Figure 1). Previous to this installation, the coil bundling crew consisted of 25 men per day; the present crew is now said to average from 12 to 15 men per day.

"THE HANDLING AND STORAGE OF REFRACTORIES"

by GEORGE H. TODD, Assistant General Superintendent, Ashland Division, Armco Steel Corp., Ashland, Ky.

▲ THE average open hearth shop, which contributes its proportion to the country's 99,000,000 yearly ingot ton capacity, is one composed of ten furnaces which produce 700,000 tons. Some 6,500 furnace repair hours are experienced in such a shop each year. At current market prices, each furnace repair hour or delay hour can be calculated conservatively to be worth $165. Mechanical methods, including the handling of refractories, continue to offer great possibilities in reduction of repair hours, greater production, and lower costs.

The average steel plant in producing 700,000 tons of ingots handles and rehandles about 300 carloads of incoming brick and 450 carloads of other refractory materials. Claims as to a shop's ability to unload direct to the job, by efficient correlation of brick shipments with scheduled furnace repairs, vary from 25 to 75 per cent. It is not likely, on the average, that 50 per cent accomplishment along this line is attained.

Improved refractories handling offers not only savings in repair time and reduction of labor, but overall improvement in labor efficiency.

One of the logical outgrowths of the increased use of mechanized handling methods, particularly after the development of the forklift truck, was the palletizing of brick.

Pallets have been standardized to 48 x 36 in. in order to be adaptable to box car widths, and to afford loads of from 3000 to 4000 pounds without making the load too high. Runners have been established at 2 in. wide by 2½ in. high which permits sufficient clearance for all standard power trucks. Single-deck pallets are standard unless double-deck are especially requested. To date, however, assembly and lumber used by suppliers varies to the extent that pallets are not interchangeable among shippers. Each supplier identifies his pallet, which must be returned before credit is allowed on the deposit made. Although insignificant as compared to the economies of the method, this is a chief and general objection by masonry superintendents.

The most common pattern of loading, and one which is becoming generally used, is known as solid loading. Single-tier pallet loading, in which solid cars requiring no gates are used, is made possible by filling in at the center of the car with about 15 per cent of the load in loose straights. By such loading, for example, a 40 ft 6 in. car will contain some 13,750 nine in. straights, have a service charge of $3, and require a deposit of $30.75 on the pallets. The only other added cost to brick delivered is the freight paid on the weight of the pallets and again when the pallets are returned in carload lots of from 1200 to 1500.

The average labor involved in unloading a conventionally loaded car is about 48 manhours. In a plant properly equipped, and experienced in handling palletized shipments, one lift truck operator and one laborer, involved in palletizing the loose brick at the doors and making whatever adjustments to bricks and pallets as may be necessary, can unload a car in less than two hours. The saving from reduced labor in unloading to storage, after deducting service charges, calculates to be about $3.25 per thousand brick. Breakage is estimated to be reduced from about four per cent to two per cent.

Truck shipments offer an attractive means of transportation for palletized brick. Whether they are to be unloaded at a brickshed, wharf, or to the ground, or to be stored about the stacks, pallets are readily removed from a flat bedded truck or trailer. Unstrapped pallets can be successfully carried on short hauls, while strapping is desirable for longer distances. Trucking offers the advantage of more prompt return of pallets to the shipper, in addition to offering possible savings in freight rates, and current receipts of smaller quantities of brick.

Service charges can be held to a low figure by close cooperation between the brick salesman and the customer on the minimum measures to insure good delivery and efficient handling. Considering average service charges, freight on pallets, reduced breakage, and the additional savings in handling, as compared to the conventional two to three additional handlings after unloading to storage, it is believed conservative to state that palletizing offers savings of at least $7.50 per thousand brick. Thus, in the average shop which consumes about 4,500,000 nine in. equivalents per year, a saving of from $30,000 to $35,000 per year is indicated on handling alone. To this sum, $10,000 may be added for each one per cent reduction in furnace repair time

made possible by the delivery of larger quantities of brick to the job.

Again, the trend toward eventual mechanization of refractory handling in brick plants and steel plants is definite. The movement is of sufficient importance to warrant reiteration in conclusion. The transition should be, and can be, speeded up by acceptance of the following suggestions:

1. Management should continue to make possible the exchange of ideas on improved methods of materials handling.
2. Management should encourage requests for facilities essential to the proper handling of palletized brick shipments and grant appropriations which appear justified by the accomplishment of facilities belonging to others.
3. Masonry superintendents who adopt it as a new method, should confine specifications on palletized shipments, as closely as possible, to loading standards already established. Steel plants and brick plants should continue to cooperate in improvement of present loading standards.
4. Brick suppliers should continue to work closely with railroads and trucking companies to assure proper transportation facilities and care.
5. Brick companies should speed up mechanization of their plants as increased volume of palletized shipments demand.
6. Suppliers should be encouraged by government and be permitted to draw up standard specifications on materials and construction to make interchange of pallets, end gates and side gates possible.

It is not unlikely, within the next five years, that as brick plants become mechanized, service charges will be removed from palletized shipments and placed against the greater labor required on loose brick shipments.

It is not likely, but possible in less than five years, that we shall again experience a drastic manpower shortage. In such a case, the greatest quantity in the least time will be all-important.

"PRESENT AND PROSPECTIVE SOURCES OF SUPPLY OF STEELMAKING RAW MATERIALS"

by C. C. HENNING, General Manager of Raw Materials, Jones and Laughlin Steel Corp., Pittsburgh, Pa., and R. W. BRAUND, Assistant General Superintendent, Jones & Laughlin Ore Co., Ishpeming, Mich.

▲ FIGURE 1, a chart of steel capacity and production (ingots and steel for castings) drawn from standard statistical sources, will give a picture of what the past experience has been.

Attention is drawn to the relationship between capacity and production for the past 36 years. The critical demands for steel production during the two war periods, 1916-18 and 1941-44, are clearly indicated. However, during the period of 1914-19 the industry operated roughly at the rate of 71 per cent of capacity. Eliminating the eight war-atmosphere years (1916-18, 1941-44), the industry operating rate was 65 per cent of capacity.

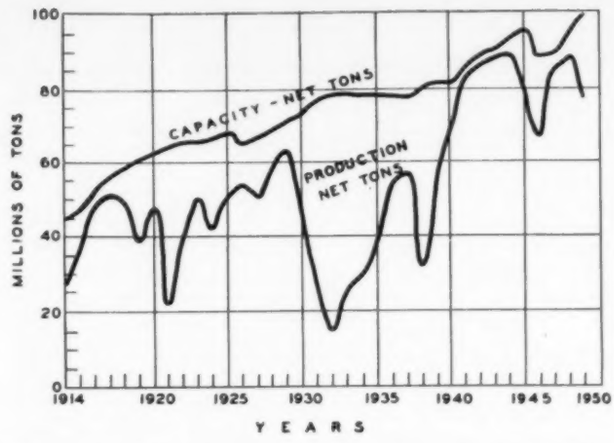


Figure 1 — The curves give American Iron and Steel Institute figures for steel capacity and steel production of ingots and steel for castings.

It has long been accepted practice to anticipate the future by studying records of the past. Hence, based entirely upon the above statistics one could assume that the average annual operating rate of the steel industry for the next ten years will be between 65 per cent and 71 per cent of present capacity. Estimates as to just what the demands upon the industry will be over this period vary widely. However, since our purpose here is to discuss the adequacy of raw materials sources to support the industry, we have chosen to proceed upon the assumption that the industry shall operate for the next ten years at a rate equivalent to 100 per cent of the present capacity of 99,400,000 net tons per year.

Estimated requirements for raw materials at a production rate of 100 per cent of present steelmaking capacity might shape up as shown in Table I.

TABLE I

Estimated Raw Materials Required Annually

	Net tons at 100% capacity
Steel produced in U. S.	99,400,000
Raw material requirements:	
Limestone and lime	33,600,000
Coking coal for blast furnace coke	89,600,000
Iron ore	107,000,000*
Iron ore — For steelmaking districts largely dependent on Lake Superior ores	93,300,000*

*Gross tons.

Limestone (including dolomite) occurs in tremendous quantities in almost all parts of the United States. Metallurgical stone of economic value is limited in quantity and location. Table II is an indication of the tonnages consumed in recent years by the steel industry.

The table indicates an average yearly consumption of 28,590,000 net tons of fluxing stone and burned lime. For present capacity operations limestone requirements would be 33,600,000 net tons. While this tonnage is

TABLE II

Limestone and Lime Consumed in Blast Furnaces and Steelmaking Furnaces
(Net Tons — Rounded Figures)

Year	Fluxing stone		Burned lime	Total
	Blast furnace	Open hearth	Open hearth and electric furnace	
1943	25,500,000	5,100,000	940,000	29,540,000
1944	23,700,000	5,500,000	910,000	30,110,000
1945	20,900,000	4,700,000	810,000	26,410,000
1946	18,200,000	4,000,000	610,000	22,810,000
1947	24,000,000	5,100,000	810,000	29,910,000
1948	26,400,000	5,400,000	930,000	32,730,000
1949	23,100,000*	4,700,000*	820,000*	28,620,000*
Average	22,830,000	4,930,000	830,000	28,590,000

Source: American Iron and Steel Institute.
*Estimated.

small compared to those of coal and iron ore it is nonetheless important as there is no substitute.

In the past there has been an abundance of acceptable stone, and other raw materials have been of suitable grade.

Transportation, or some one such item, has usually been the influencing factor in just which stone would be used. For a large portion of the industry decreasing quality of other in-place raw materials is building up a pressure that certainly will affect limestone. Relief from these pressures will be a continuing process, wherein we will find efforts at exploration and purchase of known deposits. There will also be a more intense study of production costs, transportation, quality and fluxing effectiveness.

The silica, sulphur, and phosphorous content of fluxing stone will be a matter of increasing concern.

However, an adequate supply of metallurgical stone is available today, and it is felt that an adequate supply will be available in the future. The latter will be assured through some increasing efforts on the part of exploration and improvement or expansion of present facilities.

TABLE III

Blast Furnace Coke Consumed and Coking Coal Requirements
(Net Tons)

Year	Coke consumed	Coking coal requirements
1943	56,701,000	81,468,000
1944	57,072,000	79,000,000
1945	50,653,000	72,778,000
1946	43,179,000	62,038,000
1947	57,148,000	82,109,000
1948	59,128,000	84,954,000
1949	51,784,000*	74,402,000*
Average	53,666,000	76,678,000
Required for capacity operation	62,360,000	89,600,000

Source: American Iron and Steel Institute.
*Estimated.

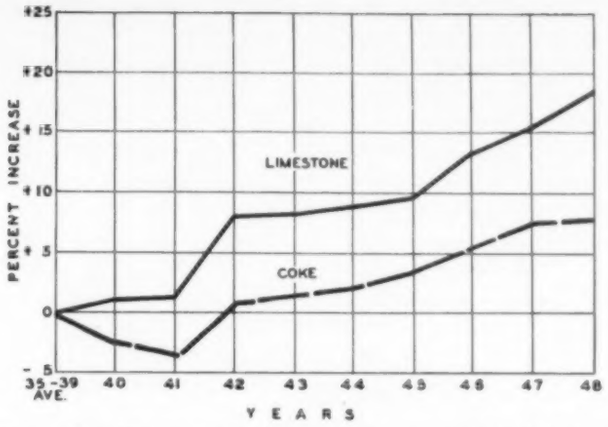


Figure 2 — The decreased quality in raw materials has required an increase in the use of limestone and coke per ton of pig iron produced. Curves are based on American Iron and Steel Institute figures.

Table III shows the blast furnace coke consumed and coking coal requirements in recent years.

One of the outstanding trends in the coal industry is the remarkable increase in washing plant capacity. In 1933 only 7,000,000 net tons of washed coal went to the byproduct ovens; in 1947 this had risen to 26,000,000 net tons for an increase of about 370 per cent. Another feature of the industry, in recent years, has been the replacement of beehive coking facilities with byproduct coking capacity. In 1948 about 92 per cent of the coke consumed in blast furnaces was produced in byproduct ovens with resultant economies in coal per ton of coke produced.

In the industry as a whole there has been a trend toward decreased quality. This decreased quality is reflected in the increase in consumption of coke and limestone per ton of iron, which is shown in Figure 2.

The sulphur and ash in coals available for the coking mix have increased appreciably as the result of mechanization, use of inferior coals, and lack of adequate washing plant facilities. This decrease in quality has brought about a sizeable increase in the use of limestone to flux off impurities. A program of postwar coal washing plants is now coming into production and a definite improvement in coking coal quality may be expected.

Various authorities in recent years have discussed the factors entering into the estimating of coal reserves. It is possible to cite published figures that vary quite widely in their totals. Some of the more recent estimates use a figure of 457 billion net tons of bituminous coal for the important eastern provinces (Pennsylvania to Alabama). It has also been stated that at least 10 per cent of all known reserves of bituminous coal east of the Rocky Mountains could be utilized as coking coals by the application of processes now in use.

Mechanically loaded coal in underground mines has increased from 12 per cent in 1935, to 49 per cent in 1943, to 64 per cent in 1948. Since mechanization will unquestionably increase, giving lower quality raw coal through full seam mining, the industry is making greater use of cleaning and blending to assure uniformity from given mines.

At the washing plants, blending of the raw coal is being done to secure a uniform feed. Today, in these

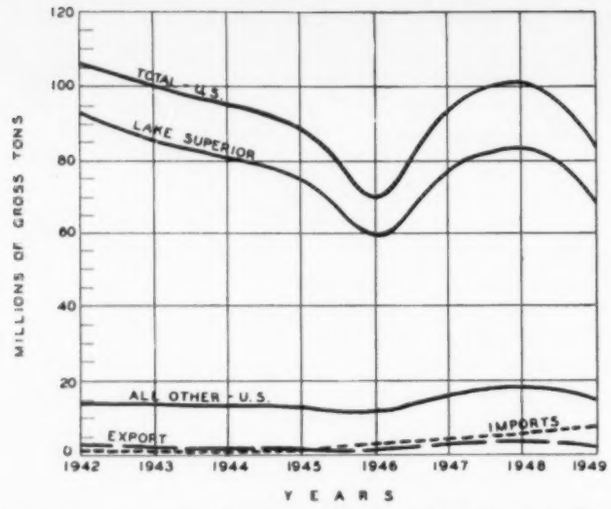


Figure 3 — L.S.I.O. Association figures for iron ore shipments by producing districts of the United States.

plants, use is being made of everything from hand picking of screened fractions to flotation of the very fine sizes. Launders, jigs, heavy density, tabling, flotation, all have found their uses. Mechanically cleaned coal has increased from about 5 per cent in 1927, to 27 per cent in 1947, to 30 per cent in 1948. There is no question but that this percentage figure will increase very materially in the future. The end result will be that additional quantities of coal will become available for coking purposes.

Blending—that uniform thread through the coal picture—continues into the coking picture. Better mixing or blending of presently available coals has been producing coke of improved and more consistent quality.

Many published articles have stated that the industry is faced with a shortage of readily available ore, that within a measurable period of time it will be unable to supply present plants with iron ore. However, in the light of rapid advances in science and other changing conditions it is felt that it is somewhat unrealistic to expect the steel industry to know specifically today exactly where its ore is coming from 25 or 50 years from now.

In late years the shipments of iron ore from the producing districts of the United States have fluctuated between a low of 70,700,000 gross tons to a high of 106,800,000 gross tons. Figure 3 depicts these shipments graphically.

On the Mesabi Range the ratio of wash concentrates to other concentrates has changed from a 15:1 ratio in the 1920s to something around 4:1 in the 1940s. This is an indication of diminishing reserves of wash ores, and the construction of jib, heavy density, or similar plants utilizing other types of intermediate ores. Additional plants to handle these types of ore are currently under construction.

For some years various articles have discussed Mesabi's future production and have pointed out the necessity of expanding underground production. Improvement in bulk handling equipment has been so rapid, however, that a very appreciable tonnage of the so-called underground ores is now being mined by open pit methods.

The Adirondack Region, after a spotty existence during the younger days of the Mesabi, is staging a vigorous rebirth that gives encouraging promise.

The Southern Region has had a very consistent production record; the operators have introduced several innovations in recent years that have aided materially in sending a more uniform ore to the blast furnace.

In the western regions the Sunrise, Wyoming, field has remained a steady shipper. New steel plants in the west have encouraged greater activity in the Iron County, Utah, deposits and also at the Eagle Mountain group in California.

Imports are becoming of increasing importance in our iron economy. Chile and Sweden have returned to their roles as major exporters to the United States. Some tonnages have been coming in from Brazil and North Africa.

Practically all our ores in the past decade have come from the above sources. The Lake Superior District, and the Mesabi Range in particular, has been the chief supplier for the industry. At no time were the mills idle for lack of ore. During this period the industry witnessed the development of the Steep Rock deposit, the resurgence of the Michipicoten area, a reawakening of the Adirondack region, and a more intensified activity in Utah.

Estimate of reserves that are or could be tributary to the steel industry of the United States have been gathered from several sources and are presented in Table IV.

TABLE IV

Probable Reserves of Iron Ore That Are or Might Be Tributary to the Steel Industry of the United States
(Gross Tons)

Mesabi Range	1,080,000,000	
Cuyuna and Vermillion	50,000,000	
Michigan Ranges	500,000,000	
Wisconsin Ranges	22,000,000	
		1,652,000,000
Magnetic Taconite	1,800,000,000	1,800,000,000
Michipicoten	100,000,000	
Steep Rock	71,000,000	
		171,000,000
Total Lake Superior		3,623,000,000
North Eastern United States	1,000,000,000	1,000,000,000
Total Tributary to Great Lakes and Eastern United States Steel Industry		4,623,000,000
Southeastern States	1,100,000,000	
Western States — Utah	500,000,000	
Balance — Western	100,000,000	
Southwestern	230,000,000	
Total — Balance United States		1,930,000,000
Labrador	355,000,000	
Venezuela	1,500,000,000	
Chile	120,000,000	
Brazil	4,000,000,000	
Total South American and Labrador		5,975,000,000
Grand Total — Wholly or Partially Tributary to U. S. Steel Industry		12,528,000,000

Our problem is not that of a shortage of iron ore, but rather the necessity of deciding just which source or sources it will be most advantageous to develop.

Some 10 years hence our potential production and probable consumption in the Great Lakes, Pittsburgh, Youngstown and Ohio Valley steel centers might shape up as shown in Table V. This is a modification of a somewhat similar chart worked up by Professor Gruner of the University of Minnesota.

TABLE V
The Probable Iron Ore Picture Ten Years Hence
(Gross Tons Per Year)

	Potential production	Estimated consumption* at 100% of capacity
Mesabi — Regular & Beneficiated Open Pit	40,000,000	35,000,000
Mesabi — Regular & Beneficiated Underground	5,000,000	5,000,000
Mesabi — Magnetic Taconite Concentrate	10,000,000	10,000,000
Total	55,000,000	50,000,000
Michigan, Wisconsin & Other Minnesota Ranges	20,300,000	20,300,000
Michipicoten & Steep Rock	3,000,000	3,000,000
North Eastern United States	6,000,000	6,000,000
Total	29,300,000	29,300,000
Labrador South America	20,000,000	14,000,000
Total	20,000,000	14,000,000
Grand Total	104,300,000	93,300,000

*Great Lakes, Pittsburgh, Youngstown and Ohio Valley Steel Centers.

Numerous papers have in their various ways raised our hopes or cast us into a state of gloom over the matter of taconites. It is felt that considerable optimism is warranted in this field since the basic process of producing high grade concentrates from magnetic taconite has been proven. The operations of Republic Steel Corp. and Jones & Laughlin Steel Corp. in the Adirondacks are an indication of what can be done in concentrating lean ores on a large scale. It is recognized that these Adironrack ores are coarser grained than most taconites, but on the other hand some of them contain less iron.

Erie Mining Co. is now commencing operations on magnetic taconites on the Mesabi Range and Oliver Iron Mining Co. is also planning a concentrating and agglomerating plant in this area. Reserve Mining Co. has done extensive research and designing on their future taconite setup and are now operating a pilot plant at Ashland, Ky., for the purpose of determining whether a satisfactory blast furnace feed can be produced by pelletizing. Other large scale tests are currently underway on pelletizing the fine-grained taconite concentrates. Operating techniques developed will inevitably become available for rapid and economical expansion of the industry. With this intensive research work it would be most unusual if an answer were not found. Inexpensive fuels from the recently discovered oil and gas fields in western Canada could have an effect on the Minnesota lean ore problem.

In review it is felt that the southern district has adequate limestone and coal for a great many years' operations. The quality of their iron ore reserves is the current limiting item in any great expansion of production capacity; imports will undoubtedly correct this factor.

The western section of the industry should have adequate limestone and iron ore to meet requirements for a considerable period of time. Exploration will no doubt develop additional ore in the promising Iron County, Utah, field. Coal will be a limiting factor at some of the mills due to a present capacity of coking coals and their distance from the mills.

For some time to come the Great Lakes, Pittsburgh, Youngstown and Ohio Valley districts will continue to produce the greatest portion of the country's iron and steel. Upon construction of the projects now in the engineering stage there will be adequate raw materials —limestone, coal and iron ore—to support the continued demands of the steel industry in this and other areas. Supply of iron ore, which has given greatest concern, will be reinforced by additional developments utilizing the intermediate and concentrating ores and also the contemplated production from the great deposits in Labrador and Venezuela.

"USE OF ELECTRONICS FOR MAIN AND AUXILIARY STEEL MILL DRIVES"

by W. R. HARRIS, Manager, Metal Working Section, Industry Engineering Department, Westinghouse Electric Corp., East Pittsburgh, Pa.

▲ ELECTRONICS, properly used, offers distinct operating advantages and it is not surprising that a large number of installations covering a wide variety of applications have been made. These applications do not fall under the classification of "fascinating gadgetry." They have been made only after careful study and analysis indicated that they would pay their way either by performing a useful task previously difficult or impossible or by doing a job better or cheaper than other methods. The following specific applications are indicative of what has been accomplished in the field of main and auxiliary drive applications:

1. Use of efficient, low maintenance ignitron rectifiers for converting a-c to d-c.
2. Precise electronic speed regulating systems for rod mills and flying shears.
3. Better air cleaning by means of electrostatic dust precipitation.
4. Tin reflow by high frequency induction heating and a sensitive electronic regulator that meters plating current to match the speed of the tinning line.
5. Photoelectric scanner devices for tin reflow control and loop regulating systems.

The typical steel plant requires a large amount of direct current power for auxiliary and main drive applications. Since power is almost universally generated as alternating current, a conversion device is needed to effect a change to direct current. Until a few years ago, motor-generator sets were used exclusively for

TABLE I

Mercury Arc Rectifiers for Steel Mill Main Roll Drive Service

No.	Year installed	Units	Total kw	Application	Mfg.	Location
1*	1942	1-3000	3,000	10 in. Hot strip mill	U.S.	U.S.
2	1943	1-2500	2,500	Merchant mill	U.S.	U.S.
3*	1945	2-3500	7,000	66 in. Hot strip mill	U.S.	U.S.
4	1949	2-5000	10,000	Hot strip mill	U.S.	U.S.
5	1949	1-1500	1,500	Seamless tube mill	U.S.	U.S.
6	1949	1-3500	3,500	Seamless tube mill	U.S.	U.S.
7	1950	3-5000	15,000	66 in. Hot strip mill	U.S.	France
8	1950	3-5000	15,000	56 in. Hot strip mill	U.S.	Austria
9	1951	3-6000	18,000	80 in. Hot strip mill	U.S.	France
10*	1950	1-4000	4,000	79 in. Hot strip mill	U.S.	U.S.
11	1951	2-5000	10,000	54 in. Hot strip mill	U.S.	U.S.
12	1940	6-2400	14,400	Hot strip mill	German	Germany
13	1950	30-700	21,000	Hot strip mill	English	Wales
		Total	124,900			

*Rectifiers on items 1, 3 and 10 operate in parallel with motor generator sets. On the other items rectifiers provide the entire finishing mill main drive d-c power supply.

this service. At the present time, a husky electronic tube—the ignitron rectifier—is replacing the motor-generator set for certain applications and paying its way by reducing operating and maintenance costs.

There is good reason for this trend. Compared to motor-generator sets, the ignitron has these advantages:

1. Higher efficiency, particularly so at light load.
2. Quiet operation.
3. Elimination of heavy foundations and ventilation.
4. High momentary overload capacity.
5. Lower maintenance costs.

For these reasons, the ignitron rectifier has also received serious consideration as the power supply for main roll drives of hot strip mills, merchant mills and the like, where, except for starting conditions and occasional adjustment, constant potential direct current is required. Table I shows the total capacity of rectifiers for main roll drives installed and on order for both domestic and foreign mills.

Table II is a tabulated comparison of ignitron rectifiers and motor-generator sets. The second column indicates to which equipment the advantage accrues and it will be noted that most of the advantages are with the ignitron rectifier. The more important advantages

TABLE II

		IGNITRON RECTIFIER	SYNCHRONOUS M-G SET
EFFICIENCY	I	Uniformly high down to low loads. No-load losses very low.	Relatively low, particularly at light loads. No-load losses high.
POWER FACTOR	MG	High — 92 to 95 per cent lagging — at rated voltage. If voltage is reduced by grid control power factor drops proportionately.	Motor can be designed to correct power factor. Power factor regulator can be used.
D-C VOLTAGE	MG	Voltage fixed by a-c supply and transformer design. A-c voltage changes transmitted to the d-c output.	Voltage fixed by machine design. A-c voltage changes not transmitted to d-c output. Change in a-c frequency will change d-c voltage.
D-C VOLTAGE REGULATION AND CONTROL	MG	Automatic voltage regulator used. No-load tap changer required for continuous operation at reduced voltage. Motors started at low voltage by grid control. Wave form and power factor bad when voltage is reduced by grid control.	Voltage regulation and control more simple.
REGENERATIVE BRAKING	MG	Not feasible because ignitrons will not transmit reverse power.	Yes.
PARALLEL OPERATION	—	Can be paralleled with other rectifiers or with M-G sets.	Can be paralleled with other units or with rectifiers.
MAINTENANCE	I	Reports from industrial users show the maintenance cost of rectifiers to be approximately 2/3 of the cost for M-G sets.	Reports from average user show maintenance cost to be approximately 50 per cent higher.
WEIGHTS AND DIMENSIONS — 15,000 KW CAP	I	Transformer, anode breakers, and rectifier assemblies. Total weight — 379,000 lb. Floor space end to end layout — 14 ft x 138 ft.	M-G sets. Total weight — 632,000 lb floor space end to end layout — 17 ft x 86 ft.
FOUNDATIONS & INSTALLATION	I	Can be mounted on any reasonably level floor, strong enough to support its static weight Installation relatively simple.	Special foundations required to withstand vibration and to provide passages for ventilating air. Careful alignment necessary.
STARTING	I	No large starting inrush. D-c voltage available instantly when switches are closed.	Large starting inrush. D-c voltage available after set is at running speed.
COOLING	I	Water-cooled. 1/3 gpm required for each 100 ampere, d-c load with 25 C water available. No air cleaning or blower required.	Air-cooled. Blowers and filters required to avoid overheating and failures due to dirt. Large volume of air required.
NOISE	I	Essentially noiseless.	Noisy.
COST	I	85-90	100

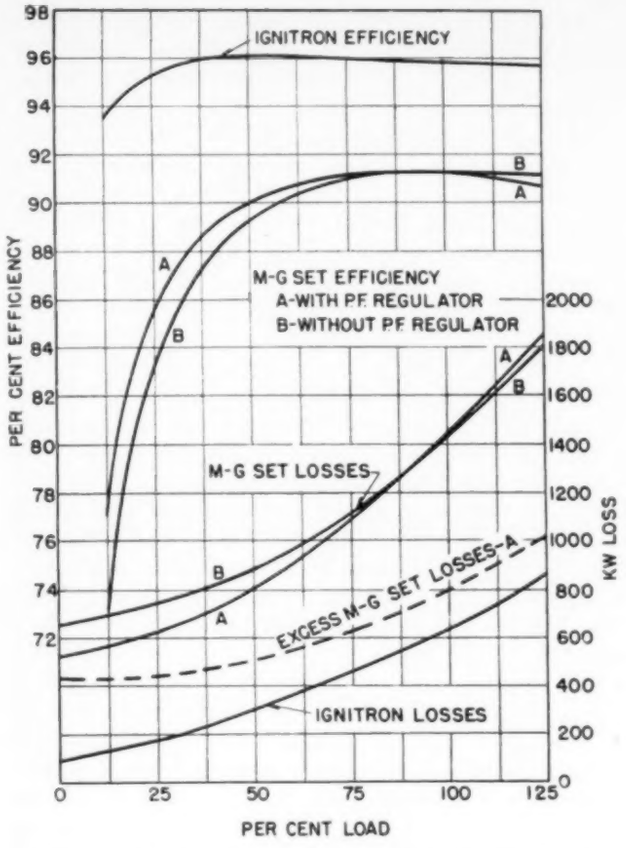


Figure 1 — Curves compare the efficiencies and losses of a 15,000-kw, 700-v rectifier with a 90 per cent power factor synchronous motor-generator set.

are lower first cost, lower installation cost, lower losses, and lower maintenance.

Figure 1 is a plot of the efficiencies and losses of a 15,000 kw rectifier and motor-generator set. The efficiency of the rectifier is much higher, particularly at light loads. The rectifier losses are 425 kw less at no-load and 1000 kw less at 125 per cent load. With the usual hot strip mill load cycles, the rectifier losses will average approximately 600 kw lower. The annual saving based on 6000 hours operation will be 3,600,000 kilowatt-hours which at one cent per kilowatt-hour is $36,000.

A large number of applications of electronic devices have been made in the field of main and auxiliary drive control. One of the most interesting of these is a fast-response speed regulator designed to minimize the transient speed changes that occur when the metal enters the rolls of individually driven rod mill stands.

Depending on the mill layout and operating speeds, it is often possible to get successful mill performance by use of specially designed low-impact drop motors with series exciters to give practically flat steady-state speed regulation. For the more difficult applications where the speed is high and individually driven stands are very closely spaced the use of electronic speed regulators is advantageous.

As a considerable amount of hot rolled strip is sold in the form of hot rolled sheets, a flying shear is required immediately following the hot strip mill finishing train. In the past, the flying shear was driven and synchronized to the last stand drive through a complex mechanical or hydraulic system, with separate electric motors to accelerate the shear. These units were cumbersome, maintenance was high, and they were not easily adjustable for different cut lengths. An improved all-electric flying shear drive controlled by a very accurate electronic regulator is paying its way by simplifying the drive equipment, reducing maintenance, and cutting sheets to lengths more accurately than with the older forms of drive.

The best indication of the success of any equipment is the number of repeat applications. A total for all manufacturers of approximately 20 such equipments are either in service or on order. Close to half of these units cover regulating equipment and control only to replace the earlier hydraulic or mechanical drives.

An interesting application of electronics which has found widespread use in steel mills is that of removing dust and dirt from ventilating air. This is accomplished by an electronic device known as an electrostatic dust precipitator such as the precipitron air cleaner. The main use in the industry is cleaning the ventilating air for the electrical equipment in large motor rooms. It pays its way by a major reduction in the accumulation of dust and dirt on electrical machinery which results in less maintenance, fewer equipment failures, and less down-time.

The electrostatic air cleaner properly applied will remove approximately 90 per cent of the dirt particles in ventilating air. Mechanical filters are not nearly as effective. They remove only the larger particles of dirt consisting of 15 to 20 per cent of the total.

The use of the electrostatic method of dirt precipitation is not new. The Cottrell system has been in use for a number of years to remove heavy industrial dusts such as those caused by boiler stacks, smelters, and cement mills. However, the high voltages used in these installations cause such a high generation of ozone that the air treated is not safe for breathing purposes, and hense not suitable for ventilating systems. The precipitron air cleaner uses essentially the same principle of operation, but is designed to operate at voltages that generate so little ozone that its concentration is on the order of that found out-of-doors on a bright sunny day.

Several million cubic feet capacity of 90 per cent efficiency precipitron air cleaners have been supplied for cleaning the ventilating air in the steel industry. Because of its high efficiency as compared to other methods, it has become the standard in the industry for this type of service.

The modern, high speed electrolytic tin plating line probably utilizes more different types of electronic apparatus than any other single application in the steel industry. Such lines may have the following electronic control and power devices:

1. A plating current-speed regulator to assure that the proper coating of tin is applied to the strip at all line speeds.
2. High frequency induction heating to reflow the tin.
3. Photoelectric scanner system to control the flow line.
4. Photoelectric loop regulators. Depending on the layout of the line several of these may be used.

"ELECTRONIC CONTROLS AS USED IN FINISHING STEEL"

by R. W. BARNITZ, Electrical Department, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

▲ IN the steel industry, the phototube is used for a variety of purposes. In the boiler house, the phototube measures stack smoke density. This data enables the operator to maintain proper combustion control. In the steel works, the phototube is used on the bessemer converter. In this application, it is focused on the flame through filters and indicates the temperature and condition of the steel during the heat. It also accurately indicates the end point of the heat. In the tin mill, the phototube is utilized as a switch in conjunction with a sheet counter, and as a pinhole detector for eliminating defective sheets.

In addition to its use as a switch, the phototube is used to control the flow of steel strip through the processing lines. It is desirable, at times, to have loops form ahead of and back of trimmers and shears. The amount of this loop can be controlled by a phototube. It is also desirable to control the winding of the coil on the tension reel so that the edges are even. Both of these operations can be controlled by phototube electronic circuits.

The heat control and duration of the weld on most flash welders is done with mechanical type contactors. However, on some welders, electronic contactors have been installed, and it is felt that the electronic tube control gives a better weld than that obtained by mechanical means.

In operation, as the strip passes through the pickle line welder, the welder gage is up, the clamps are open, the movable head is back for gage clearance and the side guards are open as shown in Figure 1. The tail end of the leading coil is sheared square at the upcut shear just ahead of the welder, then advanced beyond the welder dies and stopped. The welder gage, a wedge-shaped arm, is lowered between the dies to the bottom-most position in order to clean the dies and is then raised to the proper gaging position. The tail end of the leading strip is backed into the stationary head against the gage, which acts as a stop, and a loop is formed in the strip over the delivery table.

The leading end of the next coil is sheared, advanced in the movable head to the gage head and a loop is formed in the strip over the entry table. The side guards are closed on both the stationary and the movable heads to center both ends of the strip in the welder. The head clamps are lowered to hold the strip ends and the side guards opened. After a small time delay, the gage head raises automatically. The strip is now ready for welding.

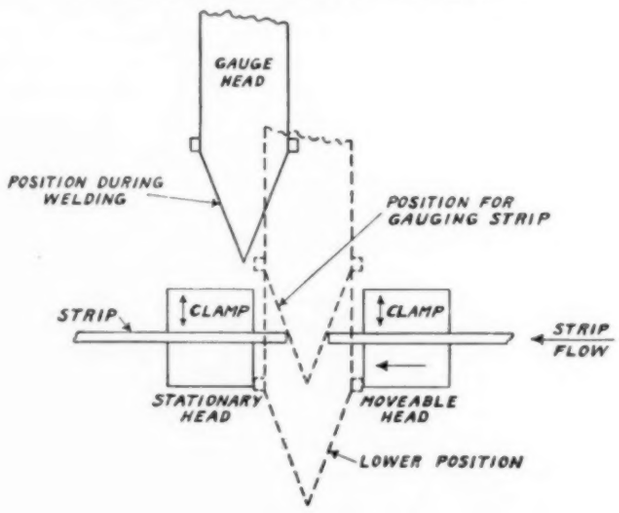
The gage position on the welder is determined by the size strip to be welded. As the two heads of the welder are always at the same relative position before and after welding, regardless of the thickness of strip, this gage head compensates for this variance. During the flashing cycle, it is imperative that the two strip ends meet at one point, rather than being parallel across the strip, in order to set up the flashing. After flashing is started, the metal is burned back from the ends across the strip. This burning causes an intense heat which conducts back into the solid metal. When this backup metal is sufficiently hot, it is ready for the upset which is merely a forging of the two metals while hot into one homogeneous mass.

In operation, when the gage reaches the top position, the flashing cycle begins automatically. This cycle consists of starting the take-up feed cylinder which moves the strip together close enough to start flashing, and starting the power feed cylinder which feeds the strip ends together as metal is burned up during flashing. At the end of flashing, the upset period occurs immediately. At the upset, after an adjustable time delay, the contactor opens; after a further time delay, the dies open, raising the upper head and the feed resets. Several seconds following the stopping of the feeding mechanism, the entry end of the pickle line starts automatically. It is stopped by the operator at the side clipper. At the side clipper, the weld along the edges of the strip is removed and the weld moved on down the pickling line to a flash trimmer where the weld is trimmed along the top and bottom sides of the strip to remove excess metal at the weld and cut the section down to gage.

The flashing time of the welder is in the neighborhood of nine to fifteen seconds while the time which the electric power is on during the upset is from one cycle to one and one-half seconds. Electronic contactors, with their exact timing and heat control necessary for this critical service, have enabled this machine to weld strip in such a manner that it is possible to run welds through the five-stand tandem cold reducing mill at normal rolling speeds, without slow down and with a weld breakage of less than two per cent. Small weld failures, in addition to the continuous running of two or more welds on the same coil through the tandem mill at regular operating speeds, enable this mill to have a higher output than heretofore thought possible with welds made with mechanical type control.

Electronic control as a voltage or speed regulator can be made adjustable over a high range of response and is used quite extensively. A typical example of this type control is in the speed regulation on wire drawing machines.

Figure 1 — Cross section of welder showing clamp and gage head arrangement at start of welding cycle.



The members of the steel industry who work in the steel producing plants usually take for granted the fact that direct current power is readily available. However, the industry has many small units which are used in the fabrication, assembly or manufacture of end products where the only power available is alternating current. It is sometimes desirable to utilize direct current in these operations because of its higher speed, higher machine output or better quality control. For an isolated installation of this type, it is possible to use an electronic installation which gives d-c machine flexibility and its advantages on alternating current power lines.

Electronic motor control, in its simplest form, consists of thyratron tubes used in the armature and field circuits of the motor to be controlled. These tubes are used for full wave rectification in the armature circuit and the field circuit or direct current machines. By controlling the time of firing of the thyratrons, it is possible to vary the voltage impressed upon the motor circuits that will maintain them at constant but adjustable values. Thus, it is possible to have wide speed variations with characteristics such as are obtainable with variable voltage systems without the rotating machinery required for these installations. It is not adaptable to reversing operations. This equipment is manufactured in sizes which will control up to 30-hp motors. One application of electronic motor control is on the rewinding operation of wire in the wire rope plants. In this application the advantages of the electronic motor control are as follows:

1. Production was increased due to higher average speed and better tension control on the wire.
2. Maintenance costs are less, due to simplification of equipment.
3. The wire speed is maintained constant.
4. Because of the arrangement of the mechanical and electrical equipment, less floor space is required per line.
5. With electrical braking on the swift, the wire is wound tighter and more uniformly on the bobbin, thus increasing the weight per bobbin.
6. With a more uniform wire lay on the bobbin, there is less wire breakage in the stranding operation.
7. Since each rewinder has its individual drive, a mechanical or electrical delay does not shut down more than one line.
8. Wire break limit switches automatically stop the machines on a wire break or at the end of a coil so that the operator can devote this time to other operations.

The maintenance problem of keeping electronic equipment in operation is very similar to that of any other electrical equipment. Checks and tests must be made periodically and a log book showing the actual history of each device should be kept. To the average maintenance man, especially the older one, this type of control is radically different from the clapper type controls with which he has been working all his life and he must, therefore, be educated in its use. Many classes have been set up for the mill men which will teach him the fundamental circuits, but in the end, he will have to learn the "know-how" on electronic control in the mill itself.

A few of the electronic controls have been covered. There are many other applications in the steel mills. Because of the great field of electronics opened during the war, many people have been under the impression that we were coming into a push button era wherein the operator touched the button and electronics would do the rest. This is not the case. There is a definite place in the steel industry for electronic controls, but in many applications, due to its high initial or high maintenance costs, rotating or static electrical controls should be installed. However, electronic controls should definitely be used:

1. Where it is operated in such a manner for which no other equipment is available.
2. Where its superior response, speed or sensitivity is required over that of other equipment.
3. Where the overall cost for doing the same job is less.

"THE PRESENT AND FUTURE OF POWER ELECTRONICS IN THE STEEL INDUSTRY"

by L. A. UMANSKY, Assistant Manager, Industrial Engineering Divisions, General Electric Co., Schenectady, N. Y.

▲ THERE are four major fields where electronics has been largely applied in the industry. They are (1) power electronics used primarily for power conversion; (2) electronic control; (3) high frequency electronic heating; and (4) electronic measurements. The steel industry has taken advantage of electronics in all four fields. New additional fields will be, undoubtedly, opened up as the art advances.

The present discussion deals primarily with power electronics, which has already won for itself in the last 10 or 12 years an important place in the steel industry and will, undoubtedly, make still greater strides in the future.

Electronics can be used for converting a-c power to d-c, and for converting a-c power from one frequency into another. The first function, well known by the name of rectification, is by far the more important one in the industry.

An ever increasing percentage of rolling mills is being provided with adjustable speed drives. For instance, even in 1931 they comprised 68 per cent of total drives purchased. In 1949 this percentage rose to 88. D-c motors are predominantly used to give the mills that flexibility which is feasible with adjustable speed. Each modern rolling mill of this type is provided with its own source of d-c power. Adjustable voltage is used to start the mills from rest. Motor field control and, sometimes, voltage control are used to adjust the operating mill speed. Voltages of 600-750 volts are usually employed for these drives.

It is the fundamental characteristic of any electronic device that the current can flow through it in only one direction; namely, from the anode to the cathode.

It is obvious also that the unidirectional characteristic of the rectifier does not permit it to carry the current in the opposite direction from the one described. This is a very important point to remember.

The value of the output d-c voltage bears a definite

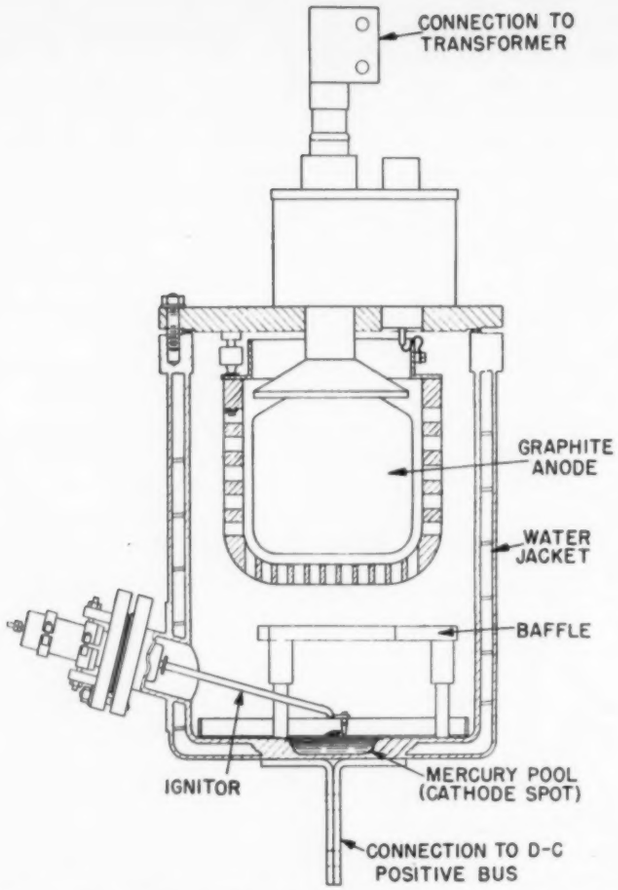


Figure 1 — Cross section of a mercury pool rectifier tank.

relation to the a-c voltage applied by the transformer to the rectifier. By changing the transformer taps, if these are provided, the d-c voltage can be adjusted. This voltage can be varied in a still different manner. By the so-called "phase control," the details of which need not be described here, it is possible to vary the fraction of the cycle during which any given rectifier tank carries the current. The shorter is this time (or, as it is said, the more "phase retard" is used) the lower is the average d-c voltage produced for a given a-c voltage applied to the transformer.

Smaller rectifier tubes are sealed off at the factory and maintain a good vacuum for several years, after which they are easily replaced. Larger units are usually assembled in groups of six or twelve tanks, together with a vacuum pump which maintains a high vacuum in these tanks. Such units are known as pumped rectifiers, and they have an indefinitely long life. At the present time the sealed rectifiers are available in sizes up to 500 kw at 250 volts, or 1000 kw at 600 volts. This limit will be undoubtedly raised in the future.

During the last 10 or 12 years more than 100,000 kw of rectifiers have been installed in the steel industry to supply 250 volt d-c power. About 90 per cent of that capacity has been provided in pumped units of 1000 kw and 1500 kw capacity. The rectifier has now fully proved its worth and is presently considered the industry's first choice for this service. It possesses a number of advantages over the motor-generator:

1. A rectifier is a static device, better suited for an unattended station than rotating machinery.
2. The rectifier efficiency is higher, particularly at part load. This results in substantial annual power savings. For instance, a 1000 kw, 250 volt rectifier energized for 7000 hours a year will probably save some 250,000 kwhr in that period.
3. The maintenance expense is lower, since there are no bearings, commutators and brushes to maintain.
4. No foundation is needed and, therefore, the installation costs are lower.
5. Rectifiers do not increase the short circuit capacity on a-c systems, as synchronous motors do. This might permit, in some cases, the use of smaller circuit breakers.

On the other hand, the power factor of the rectifier is slightly lagging (90 to 95 per cent) while that of the synchronous motor-generator is usually leading. The steel mills normally have a large number of synchronous motors on their systems; many d-c main roll drives will continue to require synchronous motor-generators to back them up. As long as these conditions prevail, the above shortcoming of the rectifier does not detract from its growing popularity. Otherwise, this shortcoming should be recognized since it can be readily compensated by the use of power-factor corrective capacitors.

The use of 250 volt rectifiers gives the steel mill another indirect advantage. Being static devices, the rectifiers can be more readily located nearer the centers of the d-c load, while the motor-generators usually need a separate room not always available or feasible at the load center. This fact reduces the length and expense of d-c feeders. In other words, it is possible to arrange the d-c power distribution on the same economical principles as is now done in the industry with a-c to a-c transformer unit substations.

The use of rectifiers for main roll drives also originated in the U.S.A. some 11 years ago when the Weirton Steel Co. had purchased two 3500 kw, 600 volt units to operate in parallel with three older 3000 kw motor-generators at its 66-in. hot strip mill. This has been followed during the war by a 2500-kw rectifier for a merchant mill at Kaiser Steel Co. The National Tube Co. installed, in 1949, a 3500 kw unit and a 1500 kw unit for two continuous tube mills at Gary, Ind. Kaiser Steel Company has, again, favored the rectifiers, and has just placed in service two 5000 kw units for its 86-in. hot strip mill. The Detroit Steel Corp. has followed this practice in ordering two 5000-kw rectifiers for its projected 54-in. hot strip mill at Portsmouth, Ohio. The Bethlehem Steel Co. has ordered a 4000-kw rectifier to operate in parallel with two 6000-kw and one 4000-kw motor-generators already installed at the 76-in. hot strip mill at Lackawanna, in order to increase the power at that mill. The Lukens Steel Co. has equipped their 276-in. hot flanging mill with a 350-hp d-c motor drive supplied with power from a separate sealed tube rectifier. Thus, about 39,000 kw of rectifiers have been installed, or are on order, for the main roll drives in the U. S. A. European steel mills have been even more favorable to the rectifiers for this application, having antedated our practice prior to the last war.

In the light of these facts it is reasonable to pause and to appraise the future trends in the use of these power electronic equipments for rolling mills.

The advantages of rectifiers for this application are substantially the same as were cited for the case of 250-volt d-c supply. Since the main drive d-c motors are usually built for higher voltage, 600 to 750 volts, the first cost of rectifier equipments per one kilowatt compares even more favorably with that of motor-generators, than is the case at 250 volts. The rectifier efficiency is also higher at higher d-c voltage. For instance, the average conversion losses in a 7000 kw rectifier are some 300 kw lower than in an equivalent motor-generator. Allowing 7000 operating hours per year, the resulting power saving will be over 2,000,000 kwhr. At a power cost of 0.7 cents per kw-hour, this saving will amount to $14,000 every year.

The factors of lower installation costs and lower maintenance usually tip the economic balance in favor of rectifiers. However, there are some engineering and operating factors which definitely limit the application of rectifiers to main roll drives.

Rectifiers are not readily suitable for such reversing drives as are needed for blooming, slabbing, plate, and other mills of this type. A reversing mill motor supplied conventionally by a motor-generator is easily accelerated, stopped or reversed by controlling the generator voltage. This is done by generator field control without disturbing the main power connections between the generator and the motor (so-called Ward Leonard system). For a substantial portion of the time the reversing motor might run at reduced voltage. When it is quickly brought to rest prior to reversing, the motor "regenerates"; i.e., it pumps the kinetic energy of rotating parts back into the generator.

In the first place, as has been already noted, the rectifier can carry current in one direction only; hence it cannot accept the "pumpback" current from the motor; nor is it suitable for causing the motor to reverse, unless the main power connections are reversed for each mill reversal. Several attempts were made abroad to get around this difficulty. This means, in effect, supplying two rectifiers, one for each direction of rotation. These attempts have proven that the rectifiers can be made to operate even under this arrangement. It is still questionable, however, whether this practice can be recommended.

Furthermore, in order to operate the motor at reduced voltage, the described phase retard must be applied. Unfortunately, when the rectifier is operating with phase retard, its power factor is reduced in about the same proportion as the voltage is reduced. Heavy peak loads at low power factor are, of course, objectionable.

In case of large reversing mills the motor-generator sets are often equipped with heavy flywheels to equalize the load peaks on the power system. This is, obviously, impossible with the rectifiers.

Summing up, then, at the present time the rectifiers and reversing hot mills cannot be considered an attractive combination.

On the other hand, the non-reversing mills, such as rod, billet, tube, hot strip, etc., lend themselves very well for rectifier applications. The d-c motors driving such mills start rather infrequently, and without metal in the rolls, i.e., at light load. The rectifier phase retard method of gradually raising the d-c motor voltage is well suited for this purpose. The operating speed range of the mills is covered, more often than not, by motor field control, which means that the rectifiers are usually operating at normal voltage with very little phase control.

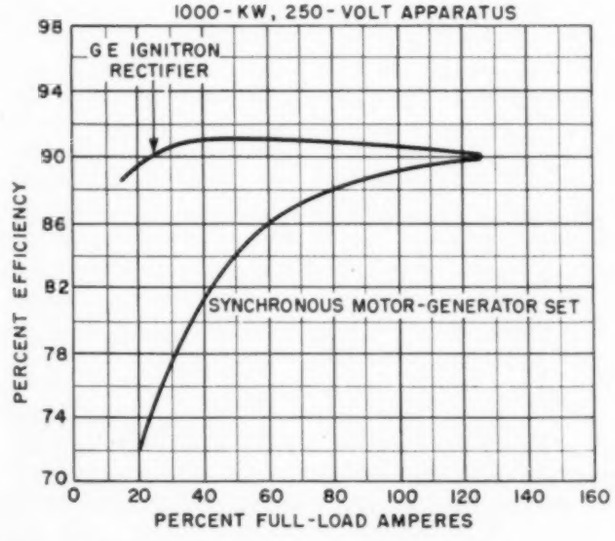
When a portion of the mill speed range is to be covered by motor voltage control, the rectifiers can still be adopted, but at some sacrifice. The extra transformer tap changing adds to the cost; phase control again affects the power factor. This may or may not be objectionable in individual cases.

If a mill of this type requires occasional reversing of one or several motors, this can be easily arranged by first bringing the motors to rest, then reversing the motor field, and restarting the motors again. Time should be given for the motor field to die down, and then for this field to build up again in the opposite direction. This will give reversing operation without the necessity of reversing the main power connections between the rectifier and the motor. This method is not suitable, of course, for frequent and rapid reversals as many truly reversing mills require.

Tandem cold strip mills accelerate from threading to running speed—and then decelerate again—for each coil, i.e., every few minutes. This acceleration is done under peak load conditions. The deceleration proceeds very rapidly with the motors pumping back into the generators. Thus, the rectifier application for these mills is not very attractive.

Summing up, then, the non-reversing hot mills constitute the most logical and promising field where the rectifiers may well be considered.

Figure 2 — The efficiencies of a 100-kw, 250-v rectifier and synchronous motor-generator, shown on these curves, emphasize the higher rectifier efficiency at part loads.



"THE USE OF THE SPECTROSCOPE IN THE STEEL INDUSTRY"

by E. O. WALTZ, Chief Chemist, Republic Steel Corp., Canton, Ohio.

▲ THE use of the spectroscope in the steel industry, prior to comparatively recent years, was confined almost entirely to problems of a research nature involv-

ing the identification of material content rather than quantitative evaluations. Only in the past 15 years has it become a laboratory tool of significance in the field of metallurgical chemical analysis.

Present steelmaking practices, such as more electric furnace tonnage, narrower specification ranges, higher scrap charges and consequent alloy contamination, slag control, etc., have only served to increase the "bottlenecking" effect of the chemical laboratory. Industry thus supplied the need and the incentive for the development of spectroscopic methods of analysis.

The difficulties encountered in the development of these spectroscopic methods of analysis were many. The spectroscope, as such, is an instrument used entirely for identification and estimation, rather than precision analysis, since its measurements are made by the visual estimation of the operator and are consequently confined to that portion of the spectrum which is visible to the human eye. By substituting a camera in the place of the human eye the spectrograph was evolved and by means of photographic plates or films a permanent record of the emission spectra of a substance may be made and evaluated.

An outline of the method employed in the analysis of steel by means of the spectrograph may be stated briefly as follows:

1. The test piece, or pieces, is made to become one, or both, of the electrodes of an electrical arc or spark gap, and with the discharge of current across the gap, minute particles of the sample burn and emit light characteristic to the elemental components of the sample.
2. The light emitted by the sample is passed through the spectrograph and recorded upon a photographic plate or film.
3. The plate or film is developed and dried.
4. The negative picture of the sample's spectrum on the plate or film is analyzed by measuring the intensities of spectrum lines in a microphotometer.

Spectrographic techniques have been developed sufficiently well enough to permit analytical results well within the limits of accuracy required in industrial laboratories. Further, the instrumentation has developed to such an extent that scientifically trained personnel are no longer required to give satisfactory performance for much of the analytical work now being done with the spectrograph, and the highly skilled spectrographer may now turn his talents to research and development of new applications of the instrument.

In the chemical laboratory servicing a steel melting unit, the spectrograph will give alloy and residual components of a heat of plain carbon, or alloy (under 5 per cent) to the melting unit within from 10 to 15 minutes from the time the sample is received in the laboratory, and with the expenditure of 1.9 man-hours of work. The spectrograph supplies the analytical results for manganese, silicon, nickel, chromium, molybdenum, copper and tin, while carbon, sulphur and phosphorus content are obtained by wet chemical methods. To obtain these results entirely by wet chemical methods would require an expenditure of at least 2.9 man-hours of work and, in a properly staffed and equipped laboratory, take approximately 30 minutes in time. Thus by use of the spectrograph we show a saving of 1.0 man-hour of work and a possible saving in furnace time of approximately 15 minutes, for each test so analyzed.

The savings in man-hours of work will not average 1.0 man-hour per test analyzed since a complete analysis is not always required on each test received. In a carbon steel shop the residual elements, nickel, chromium, copper, molybdenum and tin are of prime importance and usually one test sample taken after the meltdown period is sufficient to establish their content in the bath. In an alloy shop it may be necessary to take several test samples at various stages of the melting, refining and finishing periods to establish alloy content changes due to additions or changes in furnace conditions. Test samples taken during the teeming of a heat in general require a complete chemical check analysis, particularly for carbon, manganese, phosphorus, silicon, chromium and vanadium, which may tend to segregate in some cases. Here again the spectrograph offers an attraction in that to analyze two, three or four samples requires very little more time than to analyze one sample. A complete picture of the chemical analysis of a heat of steel, from the first ingot poured to the last, is obtained by very little increased expenditure of time and chemicals.

The average savings in man-hours of laboratory work per test is more of the order of 0.5 man-hours when we consider that some tests require only carbon and manganese, or possibly manganese only, rather than a complete analysis. The average number of tests taken per heat of steel will of course vary with the type of steel, type of furnace, and melting practice involved. This observer has seen as many as 30 preliminary tests taken on one heat of steel before it was tapped. Again heats may be made with a minimum of four tests per heat. Two preliminary tests and two taken during teeming does not appear to be an expanded figure, yet only four tests per heat at a savings of 0.5 man-hours of laboratory work per test, results in a savings of 2.0 hours of laboratory work per heat melted. A man-hour of laboratory work may be conservatively stated in money at $2.50; thus, the spectrograph may be expected to save $5.00 in chemical laboratory expense per heat melted. The more, or less, furnaces serviced, or heats produced, the more or less the savings experienced in any one steel plant chemical laboratory might be expected. In a steel plant laboratory servicing a melt shop producing 20 heats per day this savings would be $3,000 per month and, in one year, would return the investment in a spectrographic installation.

Savings are not only possible in the chemical laboratory itself. Let us look at the potential savings in furnace operating time made available through use of the spectrograph. This saving is immediately evident in the two-slag basic arc furnace practice in which a test is taken after slag-off, or after the oxidizing period, to determine the alloy content before additions may be made. After this test is taken the furnace crew must wait until the laboratory results are returned before calculating and making the necessary additions. The spectrograph will make these results available at least 10 minutes prior to the time a wet chemical result could be expected; thus a corresponding savings in furnace time of 10 minutes is possible. Later, a test is taken just prior to tapping the heat to allow a final adjustment of alloy content. Here another 10 minute savings in fur-

nace time may be realized. This estimated savings of 20 minutes per heat, at an estimated cost of one dollar per minute of furnace time, results in an estimated savings of $20 per heat. If the furnace were making three heats per day the savings could accumulate to over $21,000 per year per furnace. It is readily admitted that this savings cannot be accomplished in full due to the uncontrollable factors apparent in the melt shop itself, such as charging delays, crane delays, condition of the melt, switching of heats and other operating problems. However in a melt shop consisting of five arc furnaces and considering only one-half of the savings as actually being realized, such savings would amount to approximately $52,000 per year in furnace time.

An illustration that this savings in furnace time is an actual savings is evidenced by the increase in production of a melting unit consisting of three electric furnaces from three heats per day per furnace to almost four heats per day per furnace with the change from wet chemical control to spectrographic chemical control.

In an open hearth melt shop the time required for chemical analysis of a test is not so critical since tests are usually taken well ahead of the time of tapping and delays due to the laboratory are consequently few. Where a number of open hearth melting units are serviced, however, the laboratory man-hour savings is again apparent through use of the spectrograph.

In conclusion, let me disperse any conceptions that may have been formed that spectrographic methods can supplant, entirely, wet chemical methods. They are an aid to, rather than a substitute for wet chemistry. They will carry the burden of volume but not the whole load. Spectrographic analytical results are based upon wet chemical results of standard samples and to rely upon spectrographic results without frequent checking by wet chemical methods is to invite trouble. The common practice employed in most steel plant laboratories is to run wet chemical check analyses on one ladle sample and thus assure proper functioning of the spectrographic unit.

"THE ELECTRON MICROSCOPE IN METALLURGY"

by ALFRED L. ELLIS, Chief Research Physicist, International Harvester Co.

▲ THE electron microscope is not widely used for routine examination and inspection work in metallurgy. It is, however, becoming a useful instrument in metallurgical research. Many organizations engaged in the study of metals are using electron microscopes, and recently several interesting studies have been reported.

For many purposes, the light microscope provides the most direct, rapid and in some cases the only means of obtaining certain information about metals. It is known, however, that the light microscope has limitations. In round figures, the limit of resolution of the metallograph is of the order of 2,500 to 3,000 Angstrom units and the maximum useful magnification is about 2,000 diameters. Consequently the determination of details of shape and size of individual units of structure smaller than 3,000 to 5,000 Angstrom units requires observation with improved resolution. Resolution better than 100 Angstrom units and useful magnification of the order of 100,000 diameters can be attained with an electron microscope.

The examination of the structure of metals with the electron microscope requires the use of surface replicas. This is widely known, but the reason why replicas must be used is perhaps not so well known. When electrons are reflected from the surface of a compact object they exhibit great variation in velocity since most of them undergo considerable energy losses before they are scattered back out of the surface.

Although arrangements have been effected whereby images have been obtained, in one case these images were very faint and inferior to those of a good light microscope and in another they were very badly distorted. When thin replicas of surfaces are used, good images can be obtained. There has been some discussion as to the merits of one type of replica over another in so far as resolution is concerned, but at the present time most replica methods permit resolution of at least 100 Angstrom units. It can be said that the replication of the surface of metals for electron microscopy is more of an art than a science.

Metallurgists have expressed some skepticism regarding the interpretation of electron micrographs made from replicas. Some of this skepticism is entirely valid but some arises only from a difference in appearance of structures which on close examination are essentially the same as those one sees with the light microscope. It seems reasonable that as more work is done with the electron microscope, techniques will improve and it will become clear that there is no real difference in the general appearance of familiar structures. Of course, where the improved resolution of the electron microscope brings out details not visible with the metallograph, new interpretations will have to evolve.

"PROBLEMS OF TRUCK AND BARGE SHIPMENTS"

by H. D. RHODEHOUSE, General Traffic Manager, Republic Steel Corp., Cleveland, Ohio.

▲ THE problems (pro and con) with respect to motor truck transportation may be stated as follows:

A. *The Primary Reasons for the Use of Motor Truck Transportation*

1. Truck rates are cheaper than rail rates between many points.
2. The minimum weights on motor trucks are generally lower than the minimum carload weights of the railroads.
3. The service of motor trucks offers an attractive saving of time in transit as compared with railroad service.
4. In using truck transportation, the saving in transit time permits the buyer to operate on reduced inventories.
5. Motor carriers make deliveries to many communities not served directly by railroad.
6. The fast door-to-door service of motor trucks makes them particularly attractive in the trans-

portation of small or less than carload lots.

7. Motor trucks can make certain deliveries which are impossible of accomplishment by rail such as:
   a. To construction sites of building, pipe lines, etc.
   b. Direct to industries or warehouses not located on a railroad siding.
   c. The rail rates may be cheaper than truck rates on certain movements, but the services offered by trucks sometimes offsets such rate advantages. This is particularly true where motor truck can handle shipments to the job site as compared with the paying of a combination of rail and truck transportation charges.
8. Shipments by motor truck require little or no blocking, dunnage or weather protection, while shipments by railroad require the purchase and installation of large quantities of these materials, resulting in a heavy cost to shipper or receiver.
9. The loss and damage record of motor trucks is more favorable than the railroads.

B. *Primary Reasons Why Trucks Are Not More Frequently Used by Some Shippers*

1. Many older plants were built when rail transportation was the only method to be considered, principally because it was the only means of transportation then in use.
   a. Heavy crane facilities and rail track layouts within older steel plants cannot be readily or economically changed to accommodate trucks.
   b. Revamping of these older steel plants to permit heavy truck operations as a regular means of transportation may require construction and maintenance at heavy costs of:
      1. Suitable roadways.
      2. Additional buildings.
      3. Truck loading platforms.
      4. Crane facilities.
   c. Motor trucks are usually quite large and require considerable turnabout space not required to accommodate railroad cars.
   d. Motor trucks present a traffic control problem because the equipment cannot be "spotted" for any considerable period of time.
2. Inability to secure sufficient supply of suitable trucks.

C. *General Problems Involved in Connection with Truck Shipments*

1. There is little uniformity in the laws of the various states regarding:
   a. Load weight limitations.
   b. The size or measurement limitations of loads and vehicles.
   c. Operating permit requirements.
2. Lease-operated trucks.
   a. The lease operator or "gypsy" can often provide truck equipment on short notice. At times the registered carriers supplement their own fleets by the use of leased equipment.
   b. Criticism of "gypsy" trucks:
      1. Driver not a regular employee of the carrier.
      2. Some "gypsy" drivers are incompetent and exercise no effort to render safe and dependable service.
   c. The registered carriers who depend to any extent on the use of lease-operated trucks should police to a greater extent the work done by the "gypsy" for their account and in their name.
3. Public safety:
   a. Truck operators have a definite obligation to protect the public safety. Motor trucks in transportation service use the same highways as do vehicles of the general public.
   b. The recent rules and regulations promulgated by the Interstate Commerce Commission and some state commissions governing the loading of steel articles on motor vehicles were designed to promote safety on the highways.
   c. While the truck operator is responsible for the condition of the truck, the proper bracing, blocking or fastening of the steel to the truck, and its safe operation over the highway, shippers should help promote safety by refusing to load trucks which they can readily determine are not of the proper design or condition.
4. Weather conditions (fog, snow, ice) have a definite bearing on the time in transit and safety via motor vehicles.
5. Some consignees place limitations on the size of trucks that can be accommodated and the days of the week and the hours of the day within which receiver will unload. For example, some receivers will not unload trucks on Saturdays or Sundays nor between 5:00 pm and 8:00 am on other days.

D. *Rate Problems*

There are three factors in truck rate making which have a very direct effect upon the ability of an industry traffic man to supply quickly, reliable data on effective rates, routes and services of motor carriers to sales, accounting, purchasing or other departmental personnel. These factors are:

1. There is no definitely established formula or pattern used by all truck lines in the construction of motor truck rates on iron and steel articles within any given area or territory.
2. There is very little uniformity regarding common carrier participation in the various agency tariffs or publications. It is not unusual to find three or more truck lines participating in the same tariff offering service between two points where one or more of such carriers provide a different rate for the same service.
3. Motor carriers are permitted to serve only the points or areas and transport only the commodities authorized in the permits issued by the Interstate Commerce Commission or various state commissions having jurisdiction.
4. Contract carriers by motor truck do not publish tariffs showing contract rates. The contracts between industry and motor carriers are filed with the Commissions but are not published and distributed as are the rates of common carriers. For that reason, it is difficult or almost impossible for industry traffic men to determine the contract truck rates paid by competitors.

PROBLEMS OF BARGE SHIPMENT

While some iron and steel is shipped in larger watercraft on the Great Lakes and in the Gulf of Mexico, the movement of steel in barges is confined almost entirely

to the inland water system. These movements are between steel mills of a single company or to consignees at consuming points along the inland waterways or the Gulf Coast and territories adjacent thereto. Barge transportation is used mainly for economic reasons. It frequently permits a producer to enter markets in which he could not otherwise compete and, at the same time, enables him to reach new sources of raw materials that would not otherwise be available.

Many difficult problems are encountered in making barge shipments that are not involved in connection with rail or truck movements. Each shipment by barge is more or less a special movement and necessitates careful investigation and planning before the actual shipment can take place. In addition, there are other problems such as spotting barges at loading docks at the proper time.

"PACKAGING TIN PLATE"

by D. H. DELLINGER, Head of Service and Inspection, Weirton Steel Co., Weirton, W. Va.

▲ IT must be recognized that functionally a package contributes nothing to the usefulness of its contents. It is simply a means for converting bulk material into a suitable form for transportation and sale to the consumer. Therefore the choice of packaging methods and materials is influenced by manufacturing processes, delivery facilities, customer requirements, and other miscellaneous factors. Since the package does not enhance the product, except in such rare instances as the charred keg for whiskey, it is the function of the package to protect the contents for a minimum cost because its value is a negative factor.

Many industries use their package for eye appeal and advertising purposes. Generally the basic industries such as steel use more prosaic, utilitarian packages which can be adapted to the manufacturing processes and the requirements of the consumer.

In this respect it is interesting to note that packaging methods selected by the manufacturer often influence the requirements of the consumer with resulting economies to both. The packaging of tin plate is a particularly good example.

Currently, single-package, wooden-boxed tin plate is a very small percentage of the total production of any tin mill. In our case it is less than 4 per cent, which is probably typical. Virtually all of this material is either export tonnage to the consumers or ports not equipped to handle larger packages or secondary products such as waste waste accumulations. The boxing of production tin plate for domestic shipment is a rare procedure and it is doubtful if any mill is now equipped to box any large portion of its production.

The standard shipping bundle today is the ten, twelve, or fifteen-package unit containing 1,120, 1,344, or 1,680 sheets respectively. This is as much a requirement for the handling and use of tin plate by consumers as it is an economic requirement in the mill. In most fabricating plants consumers are equipped with automatic feeders for multiple package units and are unable today to use smaller packages without additional expense. Most coating and lithographing equipment, a primary operation on large quantities of tin plate, requires the multiple package unit for efficient operation.

In addition to providing a means for handling and shipping, the multiple package unit of tin plate must permit storage for relatively long periods of time. Again we find a unique situation in the steel industry in that large quantities of tin plate are purchased and stored in anticipation of short term, peak consumption and it is not unusual to see tin plate more than a year old in the original mill shipping container. Such material represents a carryover from short packing seasons and insurance for underestimated requirements.

As a result, it can readily be seen that the requirements for adequately packaging tin plate are extremely severe. The material is, and we repeat, fragile and perishable; a large tonnage is involved; shipping distances are great because of limited manufacturing points; and long term storage must be anticipated. The tin plate must be protected from damage in the form of bent edges and corners, from dust and dirt, and as far as possible from rust due to moisture. This last is a very controversial issue, involving not only packaging, but transportation and storage conditions as well.

In May of 1946 the Packaging Committee of the American Iron and Steel Institute was asked by the two largest can companies to review packaging methods of all tin plate producers and try to standardize basic procedure. Two general methods were agreed upon and tests were started at Weirton. The successful weather cabinet tests, in connection with satisfactory carload shipping trials, led us to revise our methods rather drastically, until the use of this new specification has now been extended to cover more than 90 per cent of our domestic shipments of tin plate at the present time. As a direct result of this standardization, packaging costs have been held at reasonable levels in the face of greatly increased material and labor costs during this period. At the same time complaints have been reduced and confusion in the mills eliminated.

A broad description of our packaging procedure follows: The selection of a platform skid is the first and an important step in the packaging of tin plate. This device evolved from the original use of two 2 x 2 or 2 x 4 skids years ago. At that time it was found that one or more sheets were marred and made unusable through vibration in transit. Experience has shown that a smooth deck surface made of hardwood boards not less than $\frac{3}{4}$ in. thick is necessary to provide a solid base. All nails must be countersunk or a portion of the sheets will be indented and marred by the nail heads.

In order to utilize automatic piling, platform skids are now made as near to but under the actual sheet size to be packaged. Solid surface decks are recommended for all tin coated products but the use of skeleton or slotted deck skids has been approved for certain special uses when specified by the consumer.

For all ordinary use, $2\frac{1}{2}$ inch high runners are standard and adequate for fork lift truck handling. However, higher runners are employed when specified for hand truck usage. It is our practice to use two runners for all tin plate sizes under 29 inches long and three runners for all sizes 29 inches and longer.

The second step, and of greatest importance in the packaging of tin plate, is good piling. The quality of this operation must be stressed constantly because it is

impossible adequately to package a poorly piled unit of tin plate. The development and expansion of electrolytic tin plate in recent years has had a noticeable effect in the mills because most of this plate is automatically piled at the cutting lines on platform skids ready for shipment. When properly piled this material resembles a solid block of steel.

The next step in packaging is the covering of the unit. We have at all times advocated the use of the corrugated fiber carton which has had widely favorable acceptance by consumers and general use by the majority of producers.

A paper inner wrap under the carton is used wherever and whenever necessary to provide a barrier against penetration of moisture and moisture vapor. Our weather cabinet testing was done primarily to select the most economical material for this purpose which would adequately protect the contents of the package. Our choice has been a waterproof paper commonly known as black and tan, made up of two layers of 50 lb kraft laminated with a 65 lb asphalt binder. The conclusions drawn from our many cabinet tests on which this choice was based are as follows:

1. Water repellent paper will not prevent loss due to severe sweating. Waterproof paper lining will minimize losses if properly used and free of tears.
2. Sealing of paper lining at the platform can best be accomplished by use of full length angles. Adhesive tape sealing has merit but is too costly and will not resist rough handling.
3. All corner angles must be cushioned to prevent tearing paper lining.
4. Tears in waterproof paper lining will show up as isolated areas of sweat rusting at any portion of the unit adjacent to the tear.
5. The metal wrapper of a metal container is not sufficient to prevent loss due to sweating without a very large overlap at the joints or the use of waterproof paper lining.
6. Newly developed rust inhibitors impregnated or coated on paper used for lining will not prevent loss due to severe sweating in a pile of sheets.
7. Under severe sweating conditions, water forms on the outside of a package, penetrating the wrapping or lining if it is not waterproof. It must be remembered that the time element is considerable, sweating frequently lasting for many hours because the mass of steel in a package warms up slowly. Exposure time is extended further by water lying in folds and crevices of the wrapping as well as under angles and ties.

The next step in packaging is the tying and angle protection to corners. Again we have a controversial subject, with both wire and band ties being used in the tin plate industry. This paper will confine itself to the placement of ties and angle protectors with only the comment that at Weirton bands are used 100 per cent.

The basic and most important part of the securement in our package is the vertical corner angles and horizontal tie which secures these four angles. They are placed over the paper wrapping of a paper lined unit. It is imperative that a piece of corrugated fiber board or chip board be placed under each angle to cushion it and prevent damaged corners. These angles and the belly tie have a dual benefit in that they prevent shifting of the sheets by holding the unit in a solid block and also give physical protection to the corners. Ordinary cold rolled sheet stock between 0.035 and 0.050 gage is used for 2 x 2 inch corner angles. Using ¾ in. x 0.028 gage band, we find out horizontal tie applied at the midpoint is adequate.

After the carton is on the unit, two ties each way are used with full length angles at the bottom and 2 x 2 x 3 in. clips at the top. Bottom angles are 1 x 3 in. applied with the short leg under the skid deck. Domestic platform skids are made with runners 2 in. shorter than deck to make application of angles easy and quick.

When no paper lining is used, full length angles are applied only on the ends, and clips used on the side.

"PROTECTION OF STEEL IN TRANSIT"

by A. H. ANDREWS, Special Engineer, Bethlehem Steel Co., Bethlehem, Pa.

▲ THE function of all handling, packaging and transportation operations is to deliver every unit of steel product to the customer in the same prime condition in which it came off the finishing unit.

It is recognized that the expense of handling and transferring does not add to the intrinsic value of the product. Therefore, the cost of these operations has been subject to close scrutiny, particularly when the rate for any part of the entire operation has changed.

Some steel products may be rugged enough and have sufficiently generous surface requirements that they can be handled with impunity through all hazards, but the majority must be protected from mechanical damage and many must be protected from damage by the weather as well.

Any package is a necessary evil. It costs material and labor to make it; it costs something to remove it and dispose of the refuse. If the package functioned as intended, the expense of its application and removal, like transportation expense, was without effect on the quality of the product. Collectively, they served the purpose of transferring the product in prime condition from finishing to consuming operation.

We like to think of warehouses as being dry. They are only relatively so. Unprotected sheets cannot be stored for long periods without discoloration of the top sheets by dust and grease and of the edges by rusting.

A sheet shipping department must be in balance with the producing units and the transportation facilities. The shipper's packaging gangs can make a certain number of packages per day. They maintain balance for an expected composition of business. If, for any reason, the packaging time is increased, this balance is lost and the departmental expense increases accordingly. The shipper will have to add men or work extra turns. Similarly, the cranes, lift trucks, and other handling equipment are in balance for a certain composition of movements through the department. A change in relative volume of business between railroad and truck, or between gondola and boxcar, or an increase in the size of sheet to be loaded in boxcars can have the same effect on the shipping department balance as a change in packaging specifications. Any persistent un-

balance in the shipping department may be the indirect cause of damage to the product.

One's first inclination in preparing a shipment for railroad movement is also to tie the load to the car so it cannot move in transit.

The obvious intention of this method of loading is to prevent movement relative to the car. A high percentage of cars loaded in this manner were delayed in railroad repair shops enroute when it was discovered that bands and blocking had been broken by the shocks of railroad handling.

In the present method of loading pipe, the pieces of pipe are bound into a unit with bands and this unit is tied to skids. There is no attempt to tie the pipe to the car. This is a typical floating load. The main idea is to permit movement of the load in the car, restricted only by friction between skids and car floor.

In preparing some floating loads a block is placed against the end gate on the floor of the car. It is expected that this will prevent damage to the end gate or to the product in case of a severe bump. End blocking gives the railroad a false sense of security. It might prevent damage to the railroad equipment and keep the load within the confines of the car, but most products will not stand being banged against anything.

In order to determine how much movement can be expected under railroad handling, we made a series of bump tests. The tests were patterned after those used by the Loading Rules Committee of the Association of American Railroads. Four products were under observation. The test involved 12 shipping units loaded on seven cars. The heaviest unit tested was a shipment of sucker rods. Velocity of impact covered a wide range.

The indicated velocity was actually the average speed of the car for the last 20 feet prior to impact. If we were doing the work again, we would favor a shock recorder.

The cars used were not specially selected in regard to type or condition of the floor. Such random selection of cars may explain some of the anomalies observed.

Figure 1 shows the relationship between velocity and movement for 18,000 lb sheet packs. These data are typical. An extensive analysis of the data indicated that the movement in inches was proportional to the square of the velocity at impact. For example, these packs of sheets would move less than 2 ft when stopped at 3 mph, 5 ft when stopped at 5 mph, and about 10 ft when stopped at 7 mph. Thus, one abrupt stop from 7 mph will cause as much shift as six similar stops from 3 mph.

The effects of speed are counteracted to a minor extent by the weight of the pack. Figure 2 shows that for a given speed (5 mph) an increase of 10,000 lb in unit weight will decrease the shift ⅔ ft. The qualitative observation is in agreement with the statement in American Iron and Steel Institute Sheet Manual, "It has been found that heavier packages withstand transportation hazards better (than light ones)."

The relation of weight to distance has practical application in commercial shipments. When a car is packed with numerous light lifts, there may be insufficient room at the ends of the car to accommodate the movement expected. The logical step is to combine the many small units into a few large units which will move less. The combination reduces the amount of floor area occupied by the shipping units, provides more space for movement, and reduces the distance the unit will shift under a given impact.

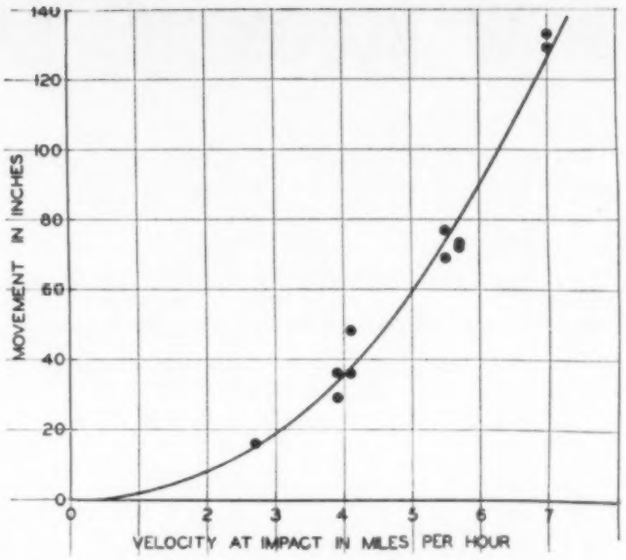
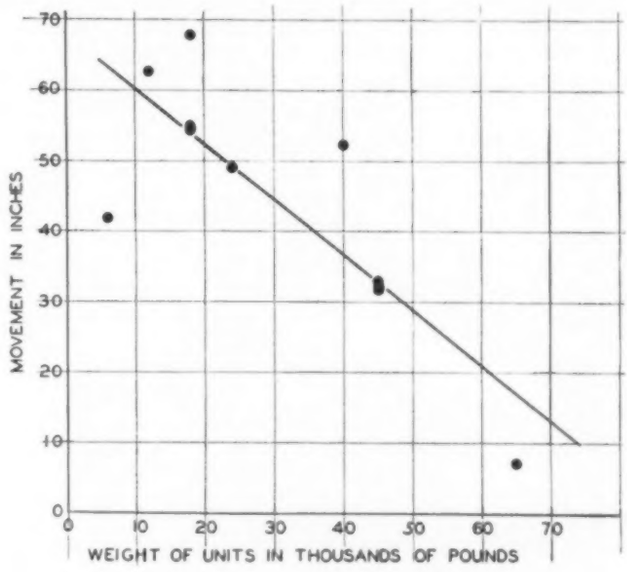


Figure 1 — The movement at impact goes up with the square of the velocity as is illustrated by this test curve for 18,000 lb sheet packs.

Figure 2 — Increasing the package weight decreases the movement.



Supposedly informed people are still inclined to believe that the way to prevent damage to railroad shipments is to brace the load against movement. Let us be realistic. Customers, carriers, and shippers can all benefit by shipment of steel in heavy units that are free to move under impact. The ideal condition would be for every car to be loaded to its legal limit by a single secured unit with enough space at the ends for the unit to move lengthwise, as required, without ramming into the end gate. If the load must be placed over the trucks, there is insufficient room for the load to float toward the end of the car when impacts occur. Such a restriction is not to the mutual interest of all concerned and should be eliminated.

NEW BLOOMING, BAR AND BILLET MILLS *of Lorain Works*

. . . . most recent developments in blooming, bar and billet mills are embodied in the unit described in the following paper . . . .

By A. F. EISEL
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United Engineering and Foundry Co.
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▲ CONCLUDING a large postwar improvement and development program at the Lorain Works, the National Tube Co. recently placed into operation extensive new steel and pipe making facilities. One of the principal additions to these facilities is the new unit identified as the No. 4 blooming, bar and billet mills. Designed to operate as a coordinated production unit occupying a single modern building 90 x 1300 ft, this installation features high production, with quality, and flexibility for diversification of semi-finished steel products such as blooms, tube rounds, billets and skelp slabs. This unit comprises four major mills: one 46 x 100-in., 2-high reversing blooming mill, one 38 x96 in., 2-high reversing bar mill, one six-stand continuous billet and bar mill, followed by a final 4-stand continuous mill. These four rolling mills all converge to finishing facilities designed to operate independently or in combination for handling all the products from the various mills.

Considering the scope of this installation, it is obviously impossible to give a lengthy description of each mill, therefore, the writer will endeavor to present only the improvement highlights with particular emphasis given to the six-stand and four-stand continuous mills.

A battery of 24 modern soaking pits to accommodate ingots 32½ x 32½ x 94 in. weighing 22,890 lb each comprises the heating facilities. The layout is designed for

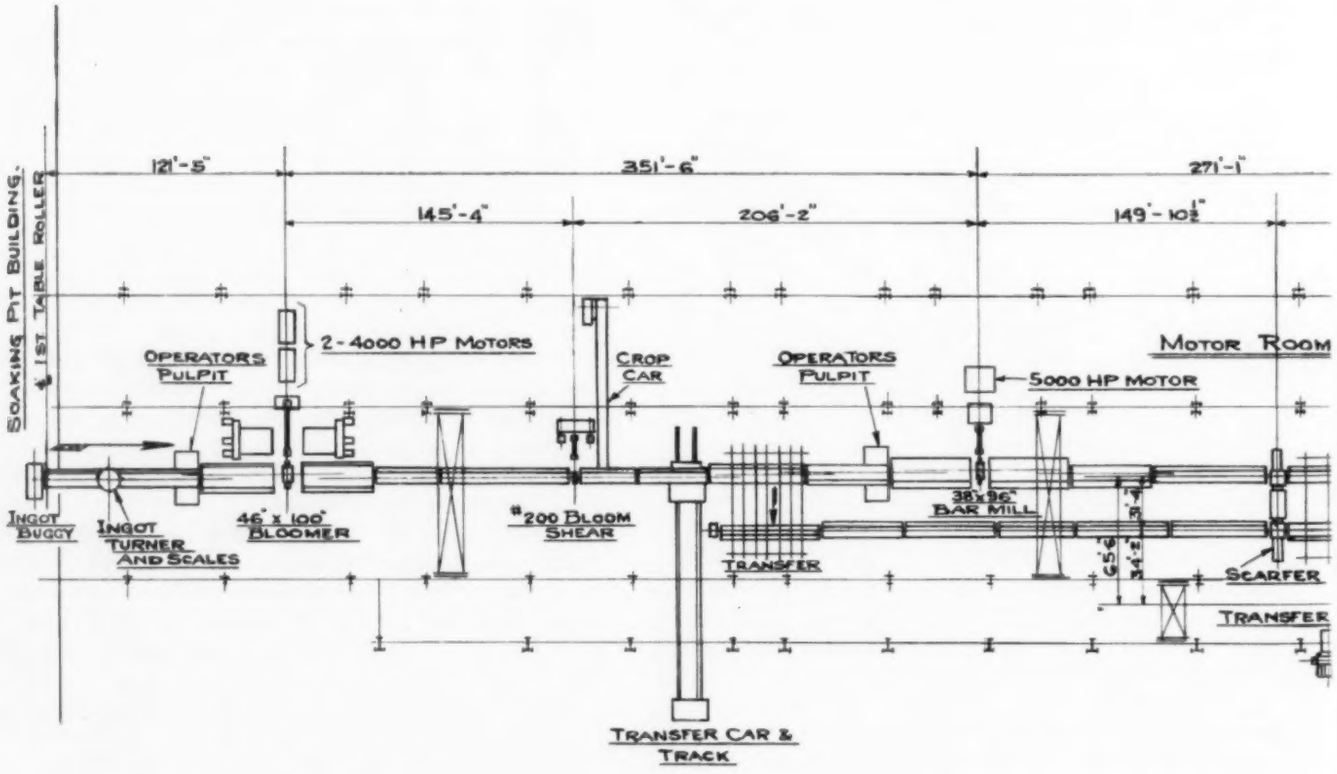


Figure 1 — Layout of No. 4 blooming, bar and billet mill.

extreme flexibility inasmuch as it must roll many sizes of blooms, billets, rounds and skelp slabs with minimum roll changes and have transfer equipment to provide several outlets for these products. Each unit will be described in the order which it functions during normal operations.

Ingots from the soaking pits are conveyed to the blooming mill receiving table by either one of two ingot buggies. Ingot scale and turntable for weighing and turning 180 degrees has been provided at this point.

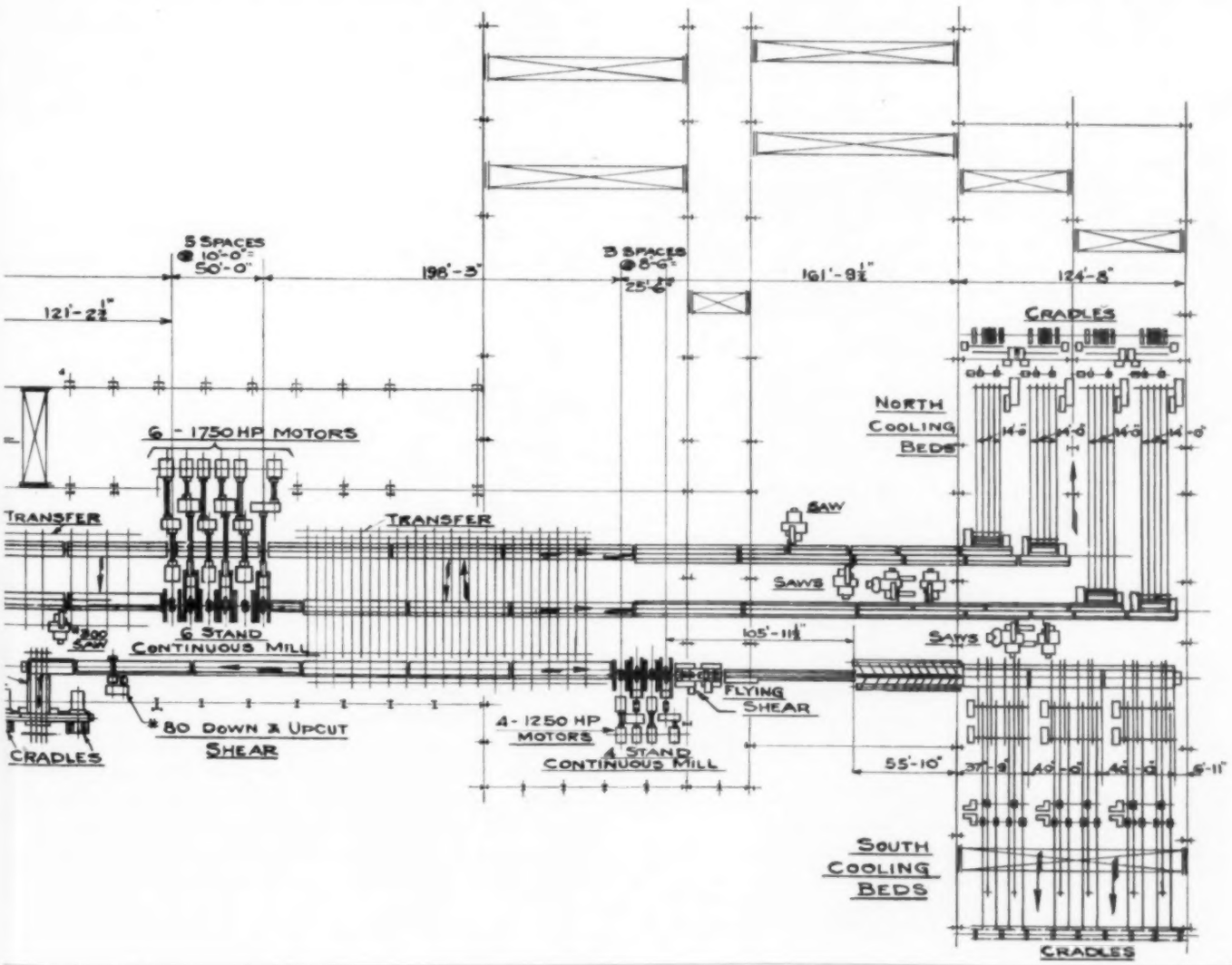
The 46 x 100 in., 2-high reversing blooming mill unit is equipped with front and back tables, individually-driven feed rollers, double rack type manipulators with tilting fingers on both sides, and hydraulic roll changing rig. Mill rolls are equipped with oil film bearings which to the writer's knowledge is the first application of this type on any blooming mill. Top roll is hydraulically counterbalanced and operated by two-motor roller bearing screwdown with mechanical and selsyn roll opening indicators. Two 15-in. diameter, 2-in. pitch screws provide a maximum roll lift of 45 in. at the rate of 230 to 460 in. per min. Mill rolls are driven directly through universal spindles and couplings by two 4000-hp, 40 to 80 rpm reversing d-c motors. Collar diameter of rolls is 46 in. with 100 in. body containing 34 in., 20 in., 15 in. and 8 in. passes $3\frac{7}{8}$ in. deep. The roll design thus avoids the common practice of too much open bullhead work tending to sharpen corners. By confining the majority of reduction in grooves with large radii, blooms are comparatively free from corner cracks and seams.

This mill rolls the $32\frac{1}{2}$ x $32\frac{1}{2}$ in. ingot to 15 x 15 in. bloom in 17 passes and is the primary section delivered by the mill runout table to the shear which is situated in line, 145 ft from the mill.

Shearing equipment at this point consists of approach table, No. 200 down and upcut motor driven shear, start and stop operation, shear crop chute, gage, crop end pusher and crop car, delivery table, one bloom pusher, transfer car and track.

After cropping, the 15 in. bloom is delivered to the 38 x 96 in., 2-high reversing bar mill situated in line, 206 ft from the shear. This unit is utilized as a secondary mill to further reduce the 15 in. bloom to 9 x 8 in. or to various large tube rounds.

At this point, attention is called to the flexibility of operations between these two mills. While the normal operating practice calls for the 15 in. bloom from bloomer to bar mill, the 46 in. mill is required to roll at various intervals smaller sizes down to 9 x 8 in. These may be rolled, cropped, sheared to required length and removed by transfer car to bloom yard. These operations may continue while rolling a 15-in. bloom on the bar mill to a 9 x 8 in. or a large round, such bloom hav-



ing been previously received from the 46-in. mill. Or, in the event of a breakdown or roll change on the bar mill which normally supplies the six-stand continuous mill, the 9 x 8 in. bloom may be rolled on the 46-in. mill, cropped and sheared to required length, then transferred to an auxiliary roller table in line with the continuous mills, thus, by-passing the bar mill entirely.

The 38 x 96-in., 2-high reversing bar mill is similar in construction to the 46-in. mill containing all its features with the following exceptions.

Mill is driven by one 5000-hp, 65 to 130 rpm reversing d-c motor through 38-in. pinion stand.

Feed rollers have been eliminated, these not being necessary due to longer bloom lengths received from the 46-in. mill.

A double carriage hydraulic roll changing rig has been provided to facilitate fast roll changes.

Integral guide units equipped with hydraulic cylinder operated releasing clamps and end screw adjustment through roll housings have been provided on both sides of the mill for each set of rolls, thus facilitating fast guide changes.

To obtain maximum rolling efficiency, the bar mill rolls are at all times provided with a 9 x 8-in. pass to feed the six-stand continuous mill, along with necessary grooves for producing a specified large tube round. The mill thus alternates from bloom to round or vice versa according to production requirements.

At this writing, four sets of 40 x 96-in. rolls have been in service to produce four current order sizes of $8\frac{13}{32}$ in., $10\frac{11}{64}$ in., $10\frac{11}{16}$ in., and $12\frac{29}{64}$ in. rounds, each set provided with necessary grooves to roll the 15-in. bloom to forementioned rounds or 9 x 8 in.

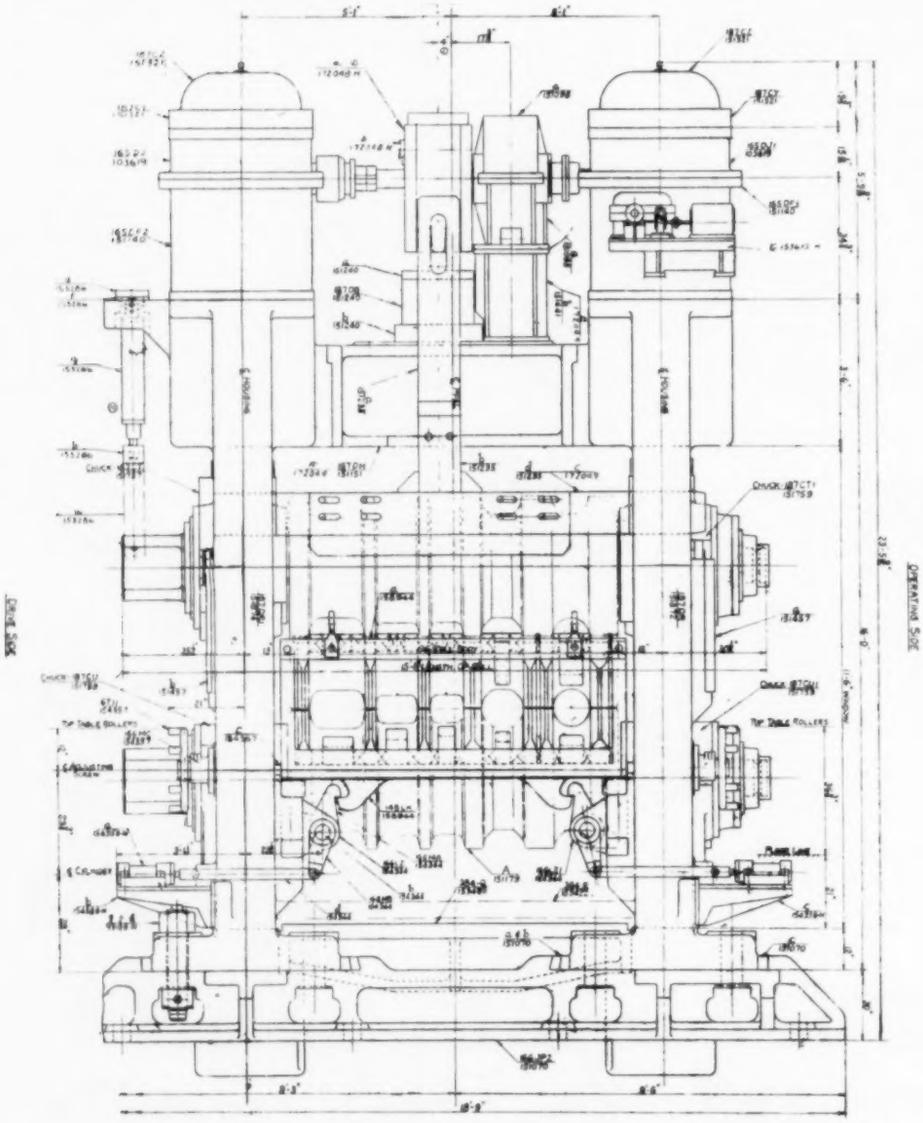


Figure 2 — General layout of roll stand of 38 x 96-in., 2-high reversing bar mill.

From the foregoing example of operating requirements, and possible future sizes this mill may be called upon to roll, it is therefore, essential to provide these fast devices to minimize roll changing time. All reductions take place in a specific groove, using the screwdown with selsyn roll indicator for obtaining the proper drafts in each groove. A predetermined setting has been established for the single pass through finishing round groove.

Each set of rolls contains 15 in., 12 in., 9 in. passes plus an octagon leader and round finishing pass with

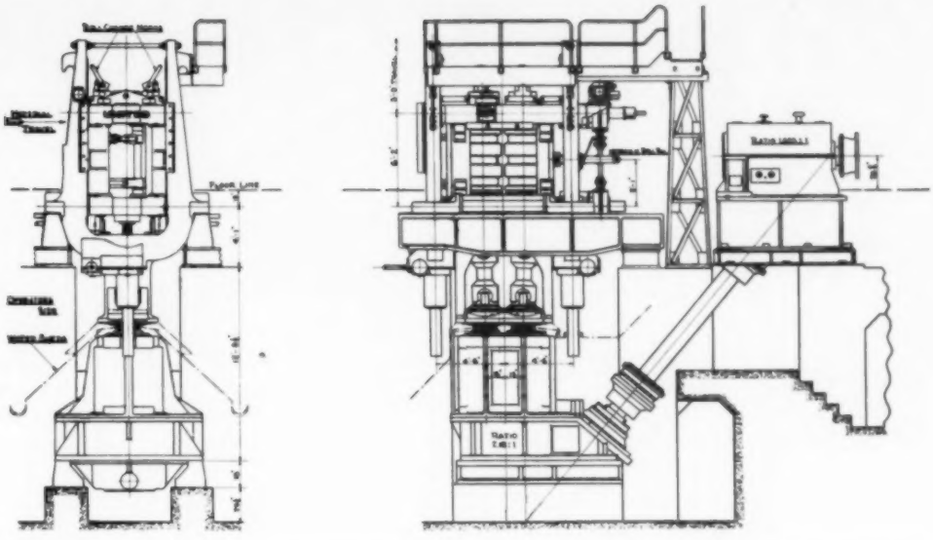


Figure 3 — General arrangement of vertical mills.

sufficient collar widths to obtain guide setting efficiency.

All large rounds are rolled direct in a straight flow line thus, from ingot through bloomer, through bar mill, to saws for cropping and cutting to required lengths, continuing on to shifting tables.

These tables are equipped with kickout devices for delivering each individual cut to chain conveyor cooling beds. Upon terminating their travel over the beds, bars are removed by a specially designed escapement device to counter-weighted chains which slowly lower them in groups to the cradles, then removed by overhead crane to storage bays for conditioning.

As previously mentioned, the bar mill must also deliver 9 x 8 in. blooms to the six-stand mill for direct rolling to billets, smaller rounds and skelp slabs. These blooms are rolled from the 15 x 15 in. in nine passes and conveyed by roller line directly from the bar mill, passing through a continuous oxyacetylene scarfing machine situated 150 ft away, then continuing on to the transfer table. Bloom is transferred to the roller line directly preceding the six-stand mill where it is cropped and divided by No. 300 saw.

If the 9 x 8 in. bloom is delivered from the 46-in. mill, it must by-pass the bar mill, therefore, the scarfing machine has been mounted on rails for convenience in shifting to position suitable for either operation. Following the scarfing, cropping and dividing operations, the 9 x 8 in. bloom enters the six-stand mill.

SIX-STAND CONTINUOUS MILL

This modern unit now in production, represents one of the major developments in rolling operations inasmuch as it embodies many features uncommon to billet and bar mills. It is also unique, in that it resembles and contains many features common to the hot strip mill plus several additional developments designed to promote flexible rolling operations.

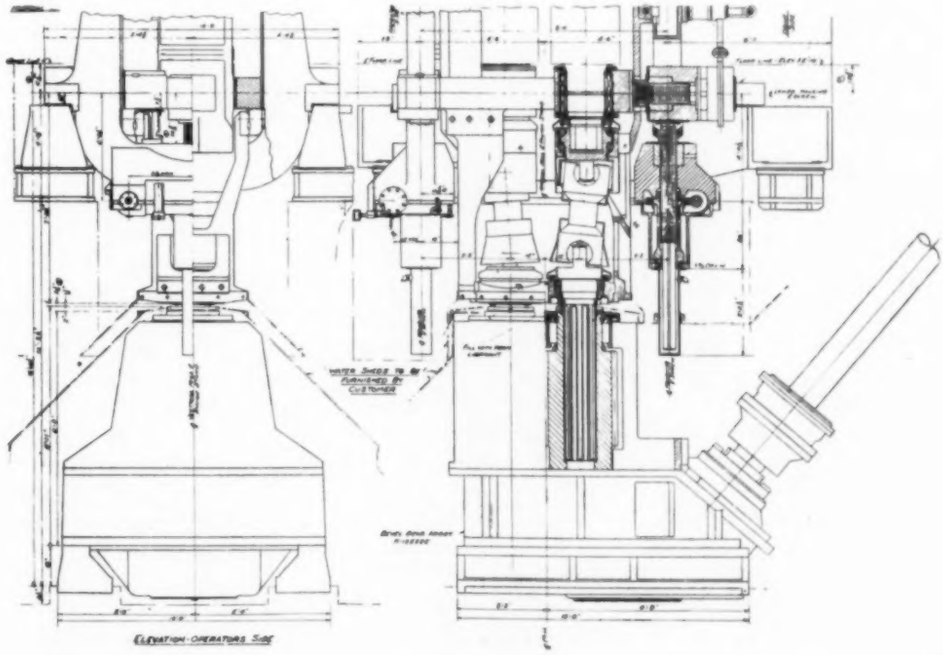


Figure 4 — Drawing shows sectional arrangement of spindles on 30-in., vertical mill.

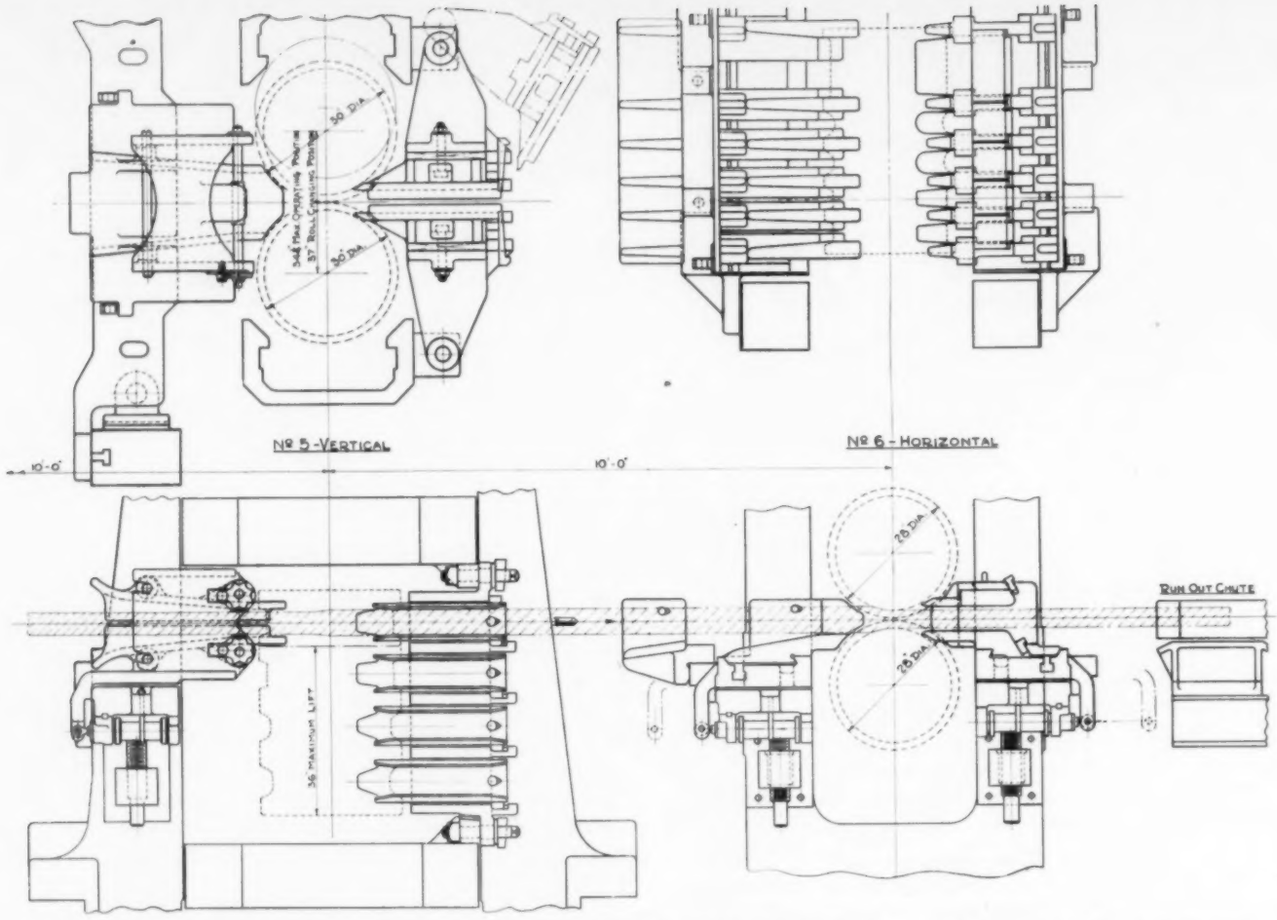


Figure 5 — General arrangement of guides for the horizontal and vertical mills. Vertical guides are shown on the left, horizontal guides on the right.

Designed to produce a wide variety of semi-finished products from 9 x 8 in. blooms, the mill is equipped to roll 4 x 4 in. billets, 5⅝ x 4 in., 7 x 4 in., 8 x 4 in., 9 x 4 in. skelp slabs, 4¾ in. and 5½ in. tube rounds on the same roll and guide setup with the ability to alternate quickly on any of the above sizes by push button controls. Additional skelp slabs up to 12 in. wide may also be rolled on the same setup from 12 or 14-in. slabs received from either bloomer or bar mills.

The mill consists of three vertical roll stands num-

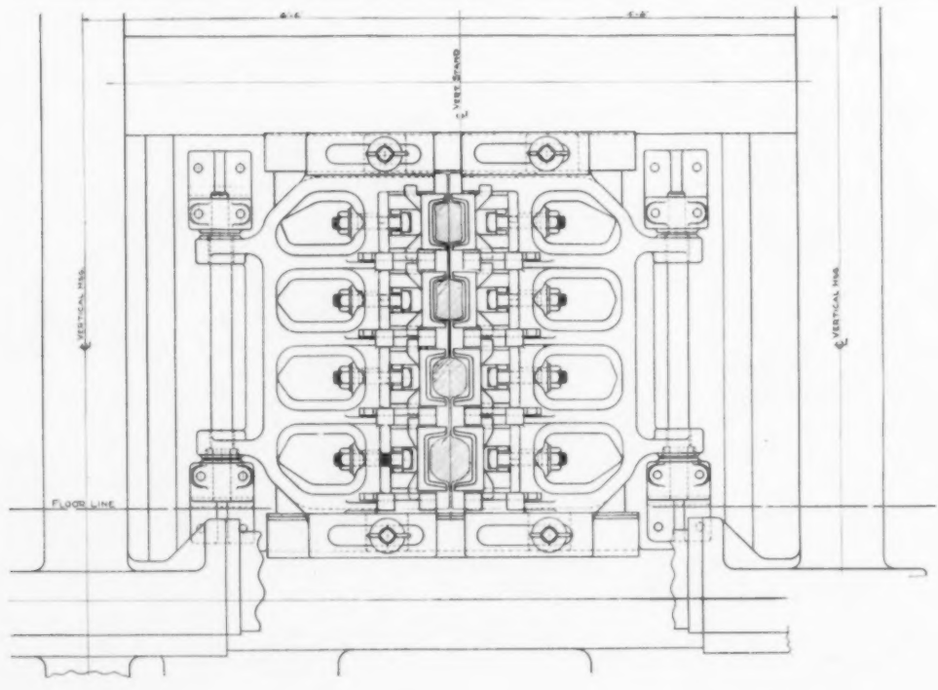


Figure 6 — Drawing shows the delivery guides of the vertical mill.

bered 1, 3, 5, and three horizontal roll stands 2, 4, 6, set in tandem on 10-ft centers. Each stand is powered individually by 1750-hp, d-c motors, 300 to 600 rpm, making a total of 10,500 hp for the six stands. Suitable gear reduction units provide for a finishing speed of 346 to 692 fpm at No. 6 stand. All vertical mills are of sufficiently rugged construction to enable drafting equal to the horizontal stands. The main vertical housing containing two 30 x 48-in. rolls, is a self-contained integral unit and resembles a horizontal stand laid over on its side. A fixed outer roll held securely by hydraulic pressure against housing seat, and a movable inner roll hydraulically balanced against motor driven screws, plus anti-friction roll neck bearings and thrust units comprise the roll adjustment. Screw speed of 6 in. per min with sufficient travel permits operating roll centers from 35¾ to 27¼ in.

Power for vertical mill rolls is transmitted from main gear drive through horizontal shaft to intermediate bevel gear drive, through 40 degree inclined shaft to combination bevel gear drive and 30 in. pinion stand fully enclosed. Universal couplings and spindles equipped with anti-friction thrust bearings suspended and attached beneath the main mill housing complete the drive. The main housing unit is enclosed within a secondary housing supported on the shoe plates. Secondary housing carries the screw-up mechanism and guiding slides for controlling the vertical movement of the main housing with respect to the horizontal mill pass line. Motor driven screw-up mechanism operates by push button control at 10½ in. per min and provides for a maximum movement of 36 in. Thus, a set of vertical mill rolls may contain several passes within this range, each of which may be properly alined with the horizontal mills. The male coupling end, transmitting motive power from 30-in. pinions through universal couplings to rolls, is forged integral with spline shaft telescoping the pinions. This arrangement permits maintaining drive connection during the upward movement of the rolls. The three vertical mills are of similar design having all parts interchangeable, including intermediate bevel gear drive. Rolls with complete bearing units are changed in pairs by means of double roll changing hooks.

Vertical mill roll and guide equipment is of such design that changes are unnecessary when rolling any of the previous mentioned sizes. Rolling time on the mill is thus increased since it is only necessary to change rolls for wear or possible breakage. The entry guide unit is attached to the secondary housing in a fixed preleveled position to accommodate upper pass in the rolls. Remaining passes may be utilized by adjusting screw up mechanism upwards, thus positioning the pass in front of the guide.

Delivery guides are set up within a swinging integral unit, including all passes in the vertical roll set. Once set in position, they seldom need adjustment, fixed roll guides remaining stationary, while the movable roll, carries the guides with its required adjustment. Upon changing the rolls, entry guide retracts clear of the rolls by hydraulic operated mechanism. Delivery guide units swing clear of the rolls by manual operation. The rolling operations of the three vertical mills in connection with the three horizontal stands will be subsequently described.

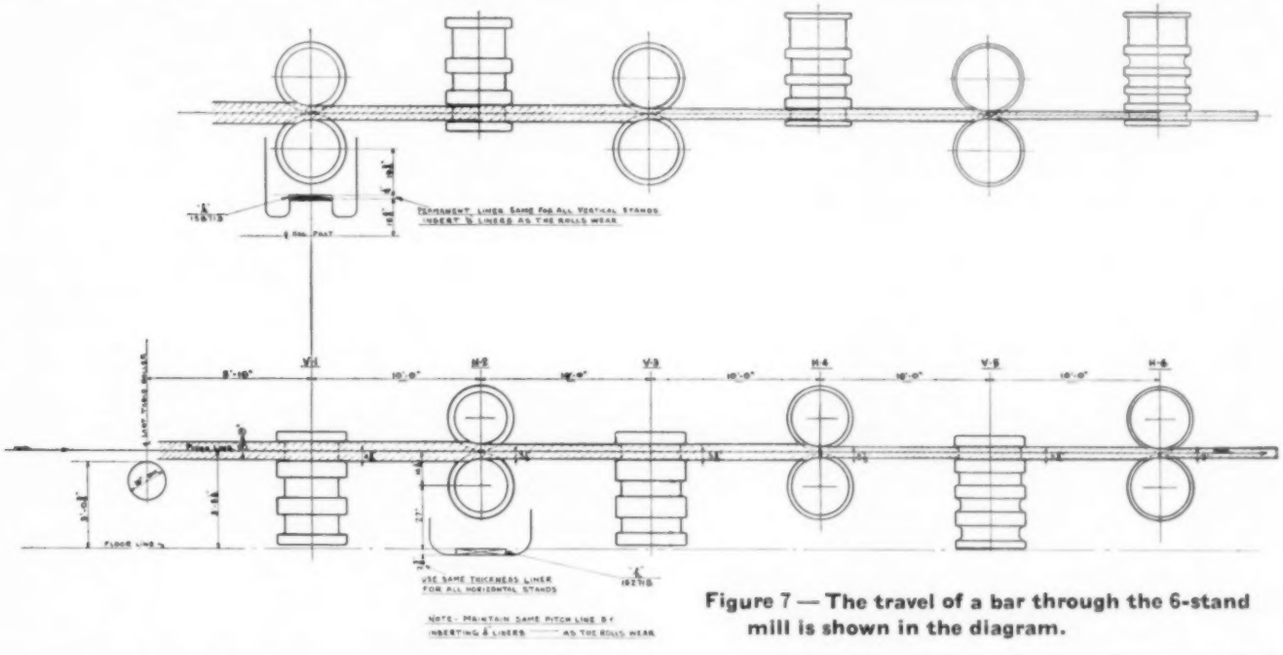
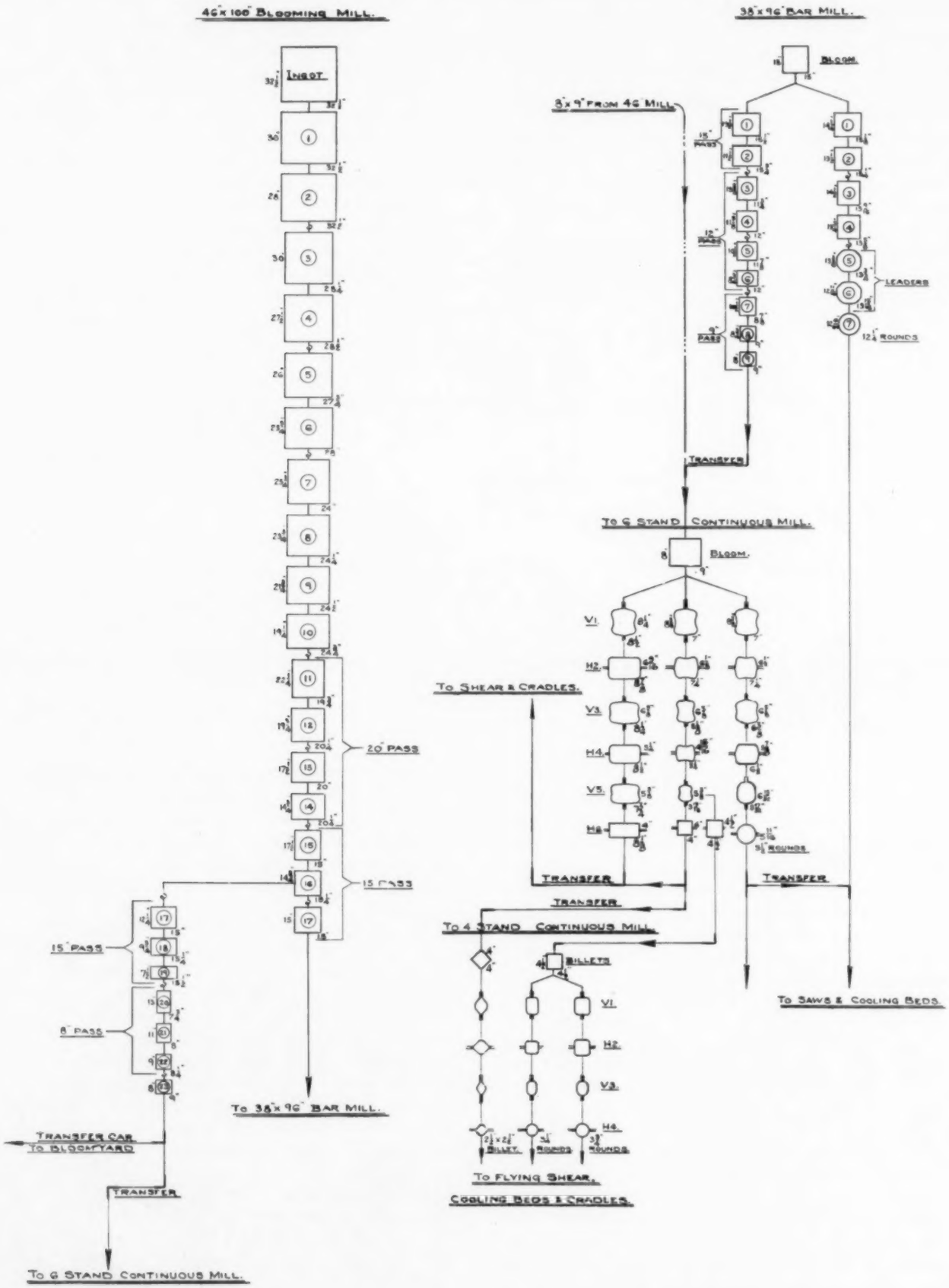


Figure 7 — The travel of a bar through the 6-stand mill is shown in the diagram.

The three two-high horizontal roll stands No. 2, 4, and 6 have strip mill construction features, having been designed for stability, smoothness of operation, accurate roll settings and ease in roll changing. Housings are of cast steel closed top construction, joined together as an intergal unit with ample flange and separator design. Top roll is hydraulically counterbalanced against motor driven screws. Screwdown is designed to permit either screw to function independently or in unison. Bottom roll is fixed, with provision on the outward chuck for endwise adjustment. Top roll outward chuck is fixed, while both drive side chucks are free to float in the housing. The 28-in. diam x 48 in. body rolls are mounted on anti-friction radial thrust bearings, all preassembled with fully enclosed chucks. Rolls are thus quickly changed by means of a C hook similar to strip mill roll changes. Horizontal roll stands

No. 2 and 4 are each driven independently through double reduction gear drive and 27-in. pinion stand. No. 6 roll stand is driven through single reduction gear drive and 27-in. pinion stand. Universal couplings and spindles mounted on carriers connect the pinion stand with rolls.

Figure 8 — The diagram shows the flow of the material from the ingot to the finished bar through the blooming, bar, and billet mill.



Another feature essential to the flexible operations of this mill is the endwise movement provided for the horizontal roll and pinion stands. To utilize all the grooves provided in the horizontal rolls for various bar sizes, it is obvious that to maintain a straight line of bar travel throughout the six stands, provision must be made for a speedy alinement of horizontal roll groove with respect to vertical roll groove. This has been accomplished by mounting the roll stand, spindle carrier base and pinion stand as a unit on the bed plate. By using the bed as sliding ways, the entire unit is movable endwise 42 in. through power supplied by 14-in. diameter hydraulic cylinder at 1250 psi.

To maintain drive connection during this operation, the main drive shaft telescopes a spline type flexible coupling at the pinion stand. Hydraulic cylinder operated quick release clamps anchor the assembly to the bed plate, thus avoiding the use of foot bolts.

Similar to vertical mills, horizontal stand roll and guide equipment is designed to roll all the previously mentioned sizes without roll or guide changes. Entry and delivery guides are mounted as integral units on sliding rest bars, which in turn are supported by the main rest bar attached securely to the roll housings. All main rest bars are adjustable vertically by means of jack screws mounted on the housings. It is obvious that rolls cannot last forever and that roll changes are inevitable. Therefore, to minimize roll changing time and thus increase efficiency, all guide equipment is designed with hydraulic retractable mechanism. All guide equipment is, therefore, moved clear of the housing window, thus permitting quick and easy removal or insertion of roll and chuck assembly.

To thoroughly understand the functions of all the foregoing features on the six-stand mill, a further explanation with respect to roll pass arrangements and their sequence of operation is as follows.

Vertical set V-1, size 30 x 48 in. is provided with three duplicate box passes 8⅜ x 7 in., all of which are completely set up with their necessary guides. Either pass may be used at all times, the 7 in. dimension varying with finished bar size and adjusted by mechanical screws on the movable roll. In the event of a worn-out pass, the roller may, by push button control, quickly raise or lower the entire main housing unit to desired position. A gage attached to the secondary housing post, and pointer on the movable housing, indicates within easy view of the operator, the proper level of the pass.

Horizontal set H-2, size 28 x 48 in., has two duplicate grooves 7¼ x 6¼ in., plus a 13-in. wide bullhead pass used for skelp slabs. The normal setting as used for 4 x 4 in., 4¾ in., 5½ in. rounds is 6¼ in. and is also subject to variation by use of the top roll mechanical screwdown. Here again all three grooves are completely equipped with the necessary guides. Roller may also move quickly to any groove by operating the hydraulic valve, thus moving the entire roll housing unit endwise. A gage on the housing shoes indicates the proper position of the horizontal groove with respect to the vertical, for straight line bar travel through the mill.

Vertical set V-3, size 30 x 48 in., also has three duplicate grooves 6⅝ x 5 in., and functions in a similar manner to V-1. The 5-in. setting is again variable with finished bar size.

Horizontal sets H-4, H-6, size 28 x 48 in., each have their designated passes for 4 x 4 in., 4¾ in., 5½ in. rounds plus skelp slab pass and have operating controls similar to H-2. Vertical set V-5, size 30 x 48 in., which is the leader, also has its designated passes. Two leader passes for the 4 x 4 in. and one each for the rounds have been provided in V-5 and H-6. Vertical set V-5 utilizes the 4 x 4 in. passes for edging skelp slabs with operating controls similar to V-1 and V-3.

From the foregoing description of the six-stand operating principle, it is self evident that size changing time has been cut to the bare minimum. Since the pass setup covers all the sizes desired, roll changes only become necessary when dressing is required.

Runout table from the six-stand mill delivers all product to transfer equipment designed to handle bar lengths up to 160 ft. Rounds may be delivered direct to either one of two saw lines, each equipped with stationary and movable saws for cropping and cutting to required lengths. Each of the saw lines converge to its own independent chain conveyor cooling bed. Or, they may be transferred to the north on the double saw line which normally handles rounds from the bar mill, each line having a single saw and individual cooling bed. Thus, the finishing equipment for tube round product from bar mill and six-stand mill, comprises six No. 300 saws, four saw lines and four north beds. All products 4 x 4 in. to 12 x 4 in. delivered from the six-stand mill for skelp conversion, are transferred to the south and conveyed by roller line in the opposite direction for shearing and transfer to bar yard. For further reduction to smaller billets and tube rounds, 4 x 4 in. or 4½ x 4½ in. billets are delivered from the six-stand mill and transferred to the south roller line directly preceding the four-stand continuous mill.

The four-stand continuous mill is similar in design and contains all the features of the six-stand mill. This mill comprises four sets in tandem, V-1 vertical, H-2 horizontal, V-3 vertical and H-4 horizontal. Each set is powered individually by 1250-hp, d-c motors, 400 to 800 rpm, with reduction gear drives designed for a finishing speed of 430 to 860 fpm. All mill rolls are 20 x 36 in. and at the present time are designed to produce 3¼ in.-3¾ in. rounds and 2½ x 2½ in. billets with sufficient available space for other sizes. Billet is delivered from the six-stand mill on the flat and prior to entering No. 1 vertical, is turned 45 degrees on the fly, by air operated turning device, thus finishing the 2½ x 2½ in. billets on the diamond.

Billets 4½ x 4½ in. enter V-1 on the flat for alternate flat and edge reduction to lead oval and finished rounds. Number 4 horizontal set delivers to flying shear for cropping and cutting to required length. A specially designed double skew table with disappearing stops, receives the bars from flying shear, where they are ganged, then conveyed in groups to roller line opposite cooling beds. Roller line is provided with disappearing stops to position these groups opposite either one of the three south cooling beds, thence traveling to the cradles and storage bays. This completes the cycle of operations from 32½ in. ingot, rolled in a single heat to all the semi-finished products mentioned above. The entire installation may be classified as an outstanding improvement and addition to American steel producing facilities.

More Power

FOR BETHLEHEM'S SPARROWS POINT PLANT

By J. M. SPENCER
Assistant Fuel Engineer
Bethlehem Steel Co.
Sparrows Point, Md.

. . . . the by-product fuels produced in the steel plant, when effectively used, can give economies in power costs . . . .

▲ IT has been realized for a number of years that the utilization of by-product fuels at the Sparrows Point plant of Bethlehem Steel Company left much to be desired. Several plans were advanced to correct this condition, but they did not materialize for one reason or another. After the war the problem was again examined, and studies indicated that the fuel available and the plant electrical load made an electrical generating station economically attractive. As a result, there has been built and put into operation a station which is presently generating approximately 75,000 kw.

The principal equipment at this station consists of two 400,000 lb/hr boilers and two A.S.M.E. Standard 33,000 kw hydrogen-cooled generators. Steam conditions at the turbine throttle are 850 psig and 900 F total temperature. The boilers are fired with blast furnace gas, coke breeze, and oil.

Figure 1 shows the increase in fuel available between 1947 and 1949 which is due to the addition of a coke oven battery and a 1600 ton per day blast furnace. The increase in burning capacity is due to the additions under discussion.

Figure 2 shows how the new generating facilities fit into the demand for energy. It should be pointed out that both 25 and 60-cycle power are used, and that the new Pennwood station is 60-cycle, while all older equipment is 25-cycle. The maximum peak load of 180 megawatts has already been exceeded, and the estimated integrated load is probably low.

The 850-psi condensing capacity at the bottom of the figure represents the new capacity, and it is seen that this station is base-loaded for a large percentage of the time. A certain portion of this 60-cycle energy is used in the 25-cycle system through the medium of frequency converters. The capacity represented as "Gas Electric" and "250-psi Condensing" is older 25-cycle capacity. The top portion of the load, as illustrated, is furnished by the local utility.

Figure 3 shows the expected 25-cycle and 60-cycle integrated loads for typical days of the week.

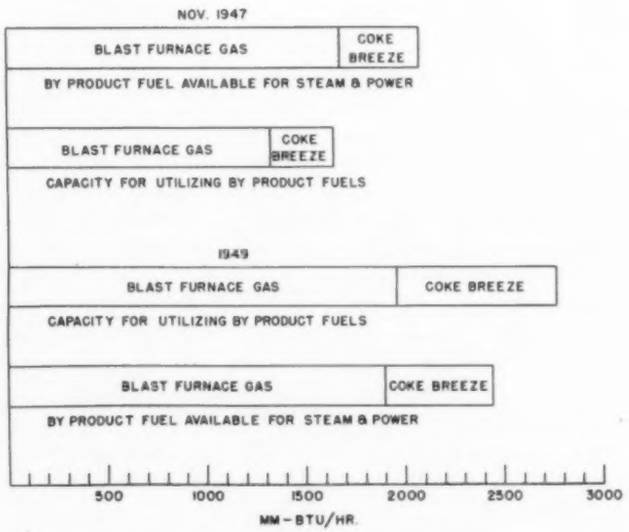
Figure 4 is a schematic arrangement of all steam and power-generating units at Sparrows Point, including the new station.

It can be seen that there are four boiler houses operating at 150 psi, together with eight waste-heat boilers. The 250-psi system is supplied by two boiler houses and the remaining 26 waste-heat boilers. The new 850-psi station appears in the lower right-hand corner, and all systems are connected through pressure-reducing valves.

Figure 5, a cross-section of the station, shows from right to left the switch yard, main transformers, electrical bay, turbine hall, boiler room, and outdoor auxiliary equipment. Note that only the boiler proper is contained in the building. All heat recovery equipment, dust collectors, and induced-draft fans are located outside.

The Patapsco River, on which the plant is located,

Figure 1 — By-product fuel available for generative steam and power versus installed by-product fuel burning capacity.



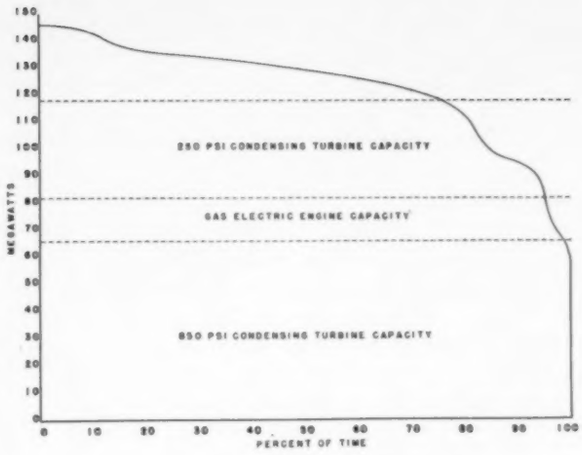
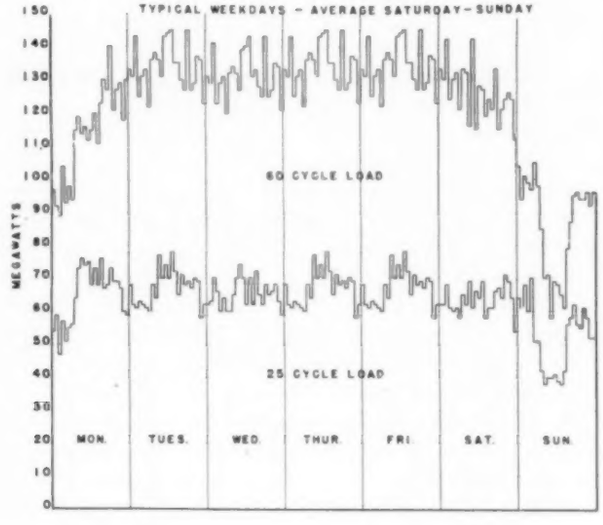


Figure 2 — Load duration curve of hourly integrated electric loads in 1949.

Figure 3 — Hourly integrated electric loads.



is in a tidal area and at times is subject to extreme variations in water level. Past experience has shown that both high water and low water can seriously disrupt operations. An attempt to meet both problems has been made at this station. The floor of the turbine hall, at elev. +3.0, is 4 feet below the maximum expected water level, and the bottom of the intake tunnel, at elev. —16.0, is 8 feet below extreme low water. This arrangement allows a variation in water level of 15 feet, and should cover any eventuality.

The separate intake tunnels may be isolated by stop logs, enabling the station to operate on either side, although at reduced capacity. Condensers are split on the vertical center line, and either half may be cleaned without taking the unit off the line. Condenser heat transfer rates are kept up by the use of automatic chlorinating apparatus.

Also shown is the coke bunker, which is fed by conveyor belt. The fuel drops by gravity to the traveling grate.

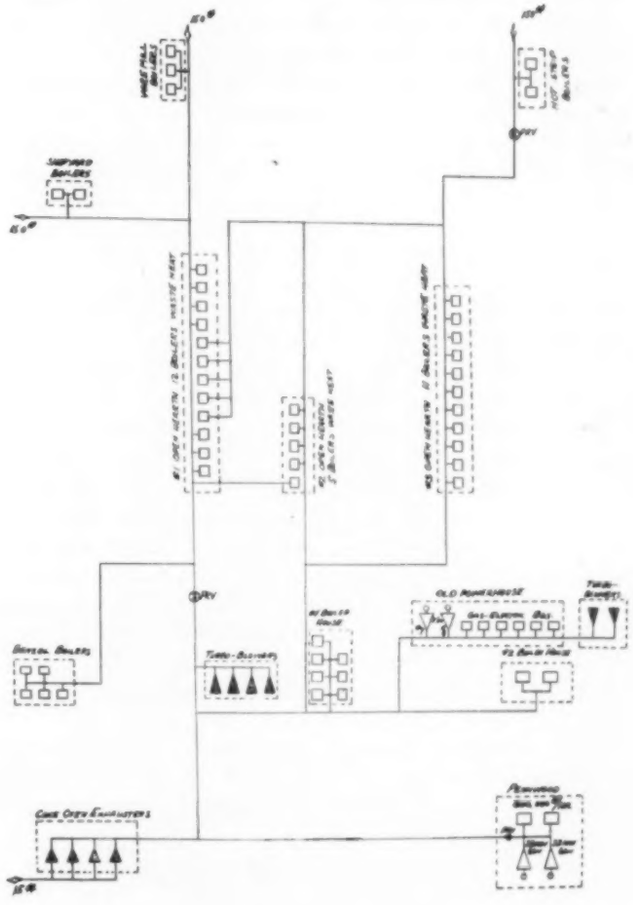
Figure 6 is a section of the steam generating units as installed. Coke breeze is burned on a 24 x 28 ft traveling grate stoker, with overfire air injected at the nose of the rear arch. Nine combination gas and oil burners are set in the rear wall. Gas flow over the superheater may travel alternate paths, as indicated by the arrows, for control of superheat. Direction of the gases is controlled by internal dampers. Interposed between the economizer and the air heater is a tubular dust collector, which may be by-passed. The air heater is unusual in that there are two paths for the forced draft. The upper half of the preheater supplies air at 600 F for the combination oil and gas burners, while the lower half supplies stoker air at 250 F. An automatic tempering damper admits the necessary amount of cold air to keep the stoker air within limits that will not damage the stoker. This construction should also help to limit the corrosion experienced on the cold end of tubular preheaters.

Certain changes which were made during the design period are of interest. It was originally planned that the boilers would have a capacity of 325,000 lb per hr, but when the contract was let it was found that certain minor changes could be made to give additional capacity.

Permissible superheater pressure drop was increased by adding $\frac{1}{32}$-in. to the drum thickness, thereby increasing drum pressure from 1000 psi to 1025 psi.

Drum and superheater safety valves were increased

Figure 4 — Schematic arrangement shows combined operation in March 1949.



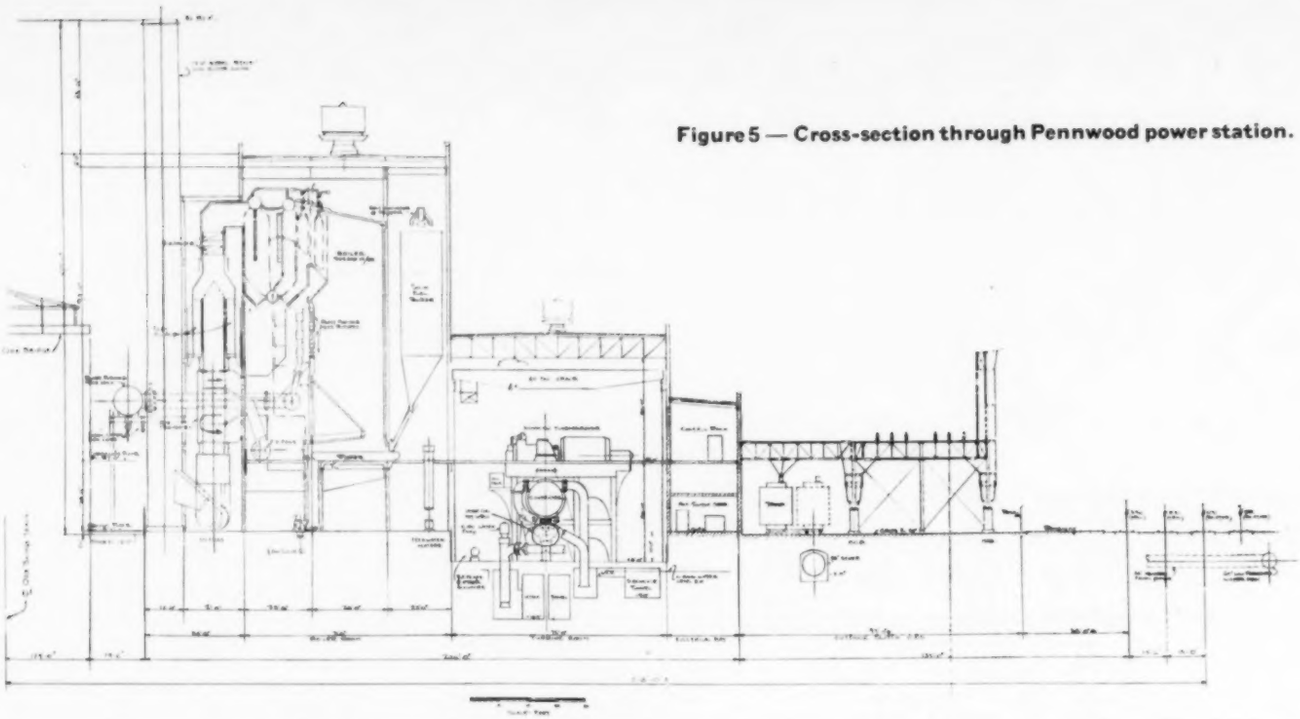


Figure 5 — Cross-section through Pennwood power station.

in size to meet the additional steam flow. Feed connections were increased from 5 to 6 in. and forced draft fan and boiler feed pump capacity were increased by using larger impellers.

As a result of these modifications it has been possible to operate these units at continuous ratings of 450,000 lb per hr. With a maximum turbine throttle flow of slightly above 320,000 lb per hr, it is evident that nearly 250,000 lb per hr is available for auxiliary drives and for bleeding to the 250-psi system.

Figure 7 shows the manner in which the various components are arranged. Examination shows that the arrangement is a three-stage regenerative cycle with an open heater interposed between the 26th-stage heater and the 20th-stage heater. The open heater is common to the feed water heating cycle of each turbine, handling all condensate from the two units plus station make-up. The turbines are constructed for five stages of extraction, only three of which are used. Exhaust steam for the deaerating heater is supplied primarily by one steam driven boiler feed pump and by the service pumps at the left of the illustration.

Previously it was noted that several hundred thousand pounds of steam were available for other uses. This steam is reduced in pressure to 275-psi and desuperheated to 660 F, and is used for station auxiliaries, service-water pump drive, and as additional 275-psi capacity for older equipment. Two 450,000 lb per hr pressure reducing and desuperheating stations operating in parallel handle this steam. For the load illustrated, a flow of 200,000 lb per hr to the mill is indicated. A 24 in. steam line, 4000 ft long, makes this steam available for the older low-pressure system.

Three alternate methods are proposed for future utilization of this degraded steam. They are:

1. Install a house turbine of about 6000 kw to top the steam to 275 psi, 650 F.
2. Build an additional boiler and install two condensing turbines.
3. Build an additional boiler and install a topping turbine to handle 600,000 lb per hr.

The service water pumps shown at the left of the illustration are an integral part of the station, but have no connection with the production of electrical energy. This equipment serves a new 25-psi water system with a capacity of 155,000 gpm. The water is to be used for six turbo-blower condensers and the condensers for the 25-cycle condensing turbines previously mentioned. One of the pumps shown provides additional capacity for the present 60-psi salt water system.

Station make-up enters the cycle at the deaerating heater. This make-up is condensate supplied from steam consumers on the 250-psi system, thus eliminating capital outlay for water-treating equipment at the new station. All treatment now in use is internal, and involves the use of phosphate, sodium sulphite, and caustic soda. The pH of the entering feed water averages 7.5 to 8.0, which is considered too low for good economizer life. It is planned to correct this situation by recirculation of boiler feed water.

Figure 8 shows both present and future 34.5-kv circuits for supplying the present and future 60-cycle load that will materialize when existing 25-cycle mills are converted to 60-cycle operation. The fundamental principle of the system is that all load eventually shall be distributed from a double-circuit transmission line forming a double loop from the power station to all of the plant load centers. Only the double-circuit transmission line to the tin and sheet mill substation has been installed to date. Junction substation will be installed along with the second half of the loop and additional generating facilities.

All 34.5-kv transmission line circuit breakers throughout the plant may be controlled from Pennwood by means of a supervisory control system.

The relaying system for power station transmission lines and substations will be chiefly a system of differential protection for the various pieces of equipment

and transmission line sections. Each 34.5-kv transmission line section between substations will be protected by differential relays operated from pilot wire with overload relays providing backup protection.

Figure 9 shows electrical connections at the station proper. To the leads of each generator there is connected a 13,800/2300-v auxiliary transformer for supplying unit auxiliaries. Unit auxiliaries operating at 2300-v are the circulating pumps, boiler feed pump, induced draft fans, and forced draft fans. Each 2300-v unit bus is protected by an automatic throw-over scheme which supplies power from the station 2300-v bus and thus maintains power to the auxiliaries.

Station auxiliaries as differentiated from unit auxiliaries are supplied through a 34,500/6900-v transformer, a 6900/2300-v transformer, a 2300/440-v transformer and necessary switch gears.

Main transformers are 13,800/34,500-v, 37,500 kva and are connected through oil circuit breakers to the buses in the switch yard.

Water for the condensers and for the mill service pumps is supplied through a canal, see Figure 10, approximately one mile long. Inlet and outlet are divided by sheet steel piling, and two sluice gates between inlet and outlet have been provided for recirculation during extremely cold weather. Under future demands and at the lowest expected tide the canal should furnish 370,000 gpm.

Figure 11 illustrates the 120-in. overhead gas main which delivers roughly 10,000,000 cfhr to the boilers. Carried on the same structure are the 24-in. steam lines previously mentioned, fuel oil line, air line, and condensate line for make-up. "H" furnace appears in the background.

Figure 12 shows a picture of a model of the station. The coke handling system and inlet and outlet canals are clearly shown. The inlet, or left side of the canal, is protected against debris by bar screens followed by four traveling screens. At the rear of the building is shown all of the external heat recovery equipment, and the induced-draft fans and ash-handling equipment.

This station has been operating for about four months with good results. Production of electrical energy averages 73 megawatts and about 150,000 lb per hr is bled to the steel plant at 275 psi. If it is considered that this bled steam is used for power generation

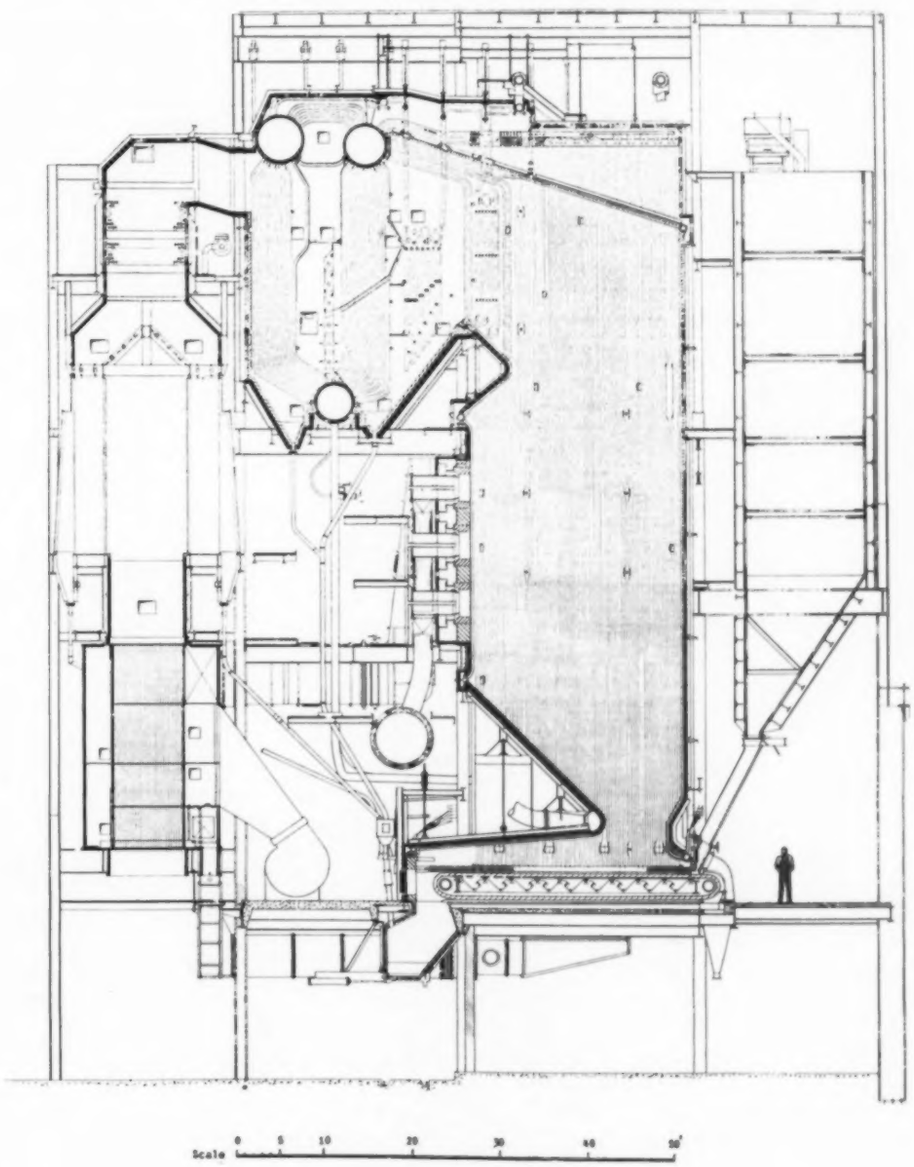


Figure 6 — Sectional elevation through boiler.

on the older units, the total generation provided by this new plant is about 85 megawatts.

During the design stage there was some question as to availability of the boilers from a standpoint of cleanliness. The blast furnace gas used in the other boilers has a dust content of about 0.08 grains per cu ft, and it was felt that this dust loading might cause serious difficulties. A number of water sprays were installed in the gas main in an effort to reduce the dust loading, and recent tests show that the sprays reduce the dust content to 0.03 grains per cu ft. Experience has shown, however, that any dirt deposited is scrubbed out by erosion from stoker carry-over. The matter of erosion is being carefully watched. At each opportunity, tubes are micrometered to determine wear, and all other surfaces are given close inspection. No measurable amount of wear has been observed as yet.

Considerable trouble has been experienced with superheat control. At times, as the availability of gas decreases, gas flow may be decreased from 4,500,000 cfhr to 2,000,000 cfhr in a period of two or three minutes. Fuel oil and/or coke breeze are required to hold boiler rating, and the consequent change in mass flow upsets superheat temperature. This has been minimized to some extent by the installation of a small additional baffle and an increase in the air-fuel oil ratio, but much remains to be done.

No. 1 boiler has been plagued with recurrent leaks at the rolled joints on the lower side water-wall headers. These leaks do not occur while the unit is steaming, but generally appear after the unit is off the line and has cooled down. It is planned to seal-weld these tubes at the next opportunity.

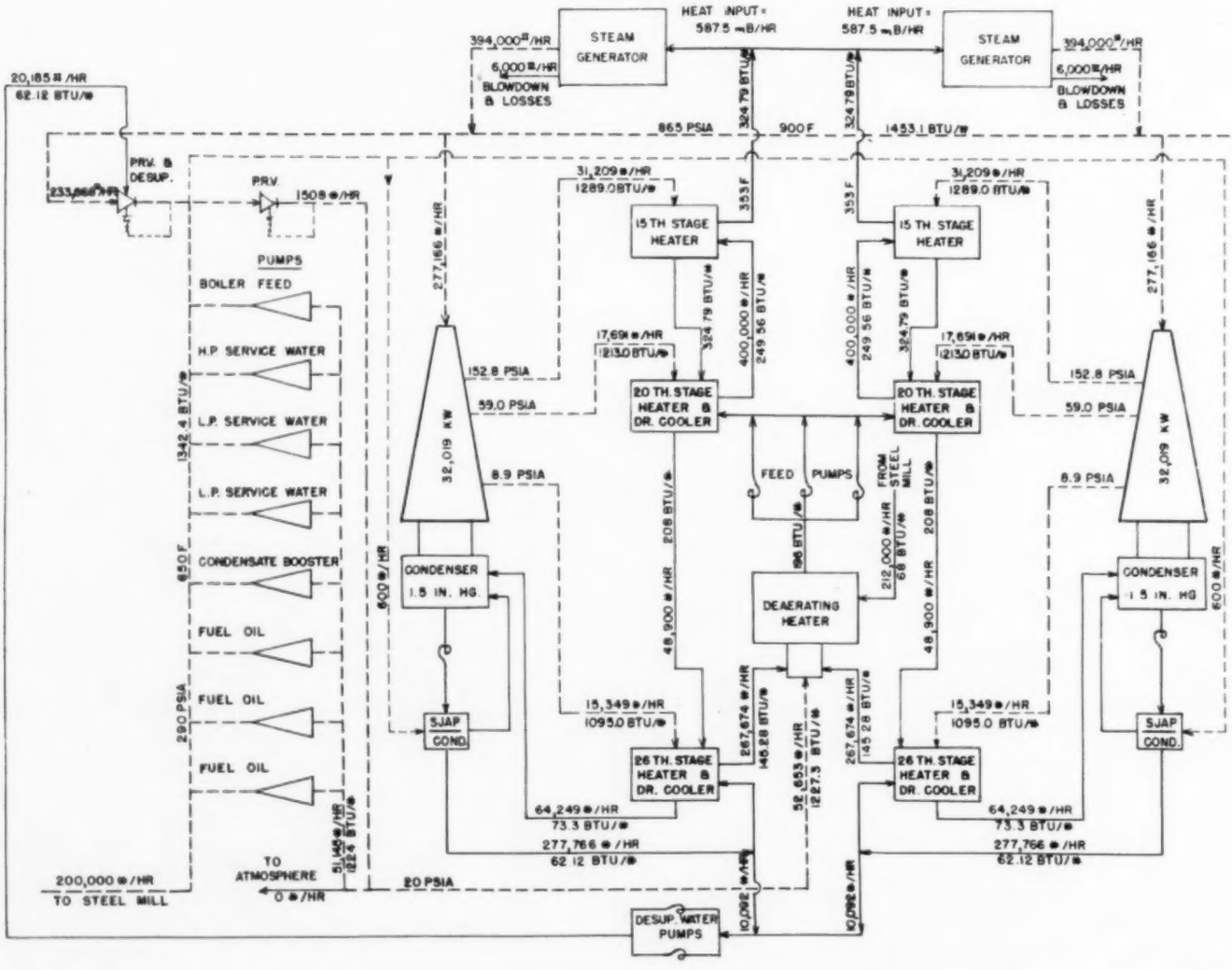
Some trouble has been experienced with valves of the pressure-seal bonnet type. One valve leaked because of a faulty casting and several others were apparently poorly assembled at the factory.

On three or four occasions the main conveyor belt was damaged due to faulty operation of the hold-back. New holdbacks are being furnished by the vendor.

Operation of the turbines has been generally satisfactory except for several occasions when the unit dropped load for reasons not yet determined. In each case the unit was operating on load-limit control, and the problem has been solved temporarily by not using this control. No. 2 turbine has tripped off the line three times, once while carrying full load of 37 megawatts. Two instances were due to incorrect setting of electrical relays, and the third due to loss of field.

Several serious accidents were narrowly averted

Figure 7 — Heat balance diagram for 32,019 kw gross generation per unit and 200,000 lb steam per hr to steel mill.



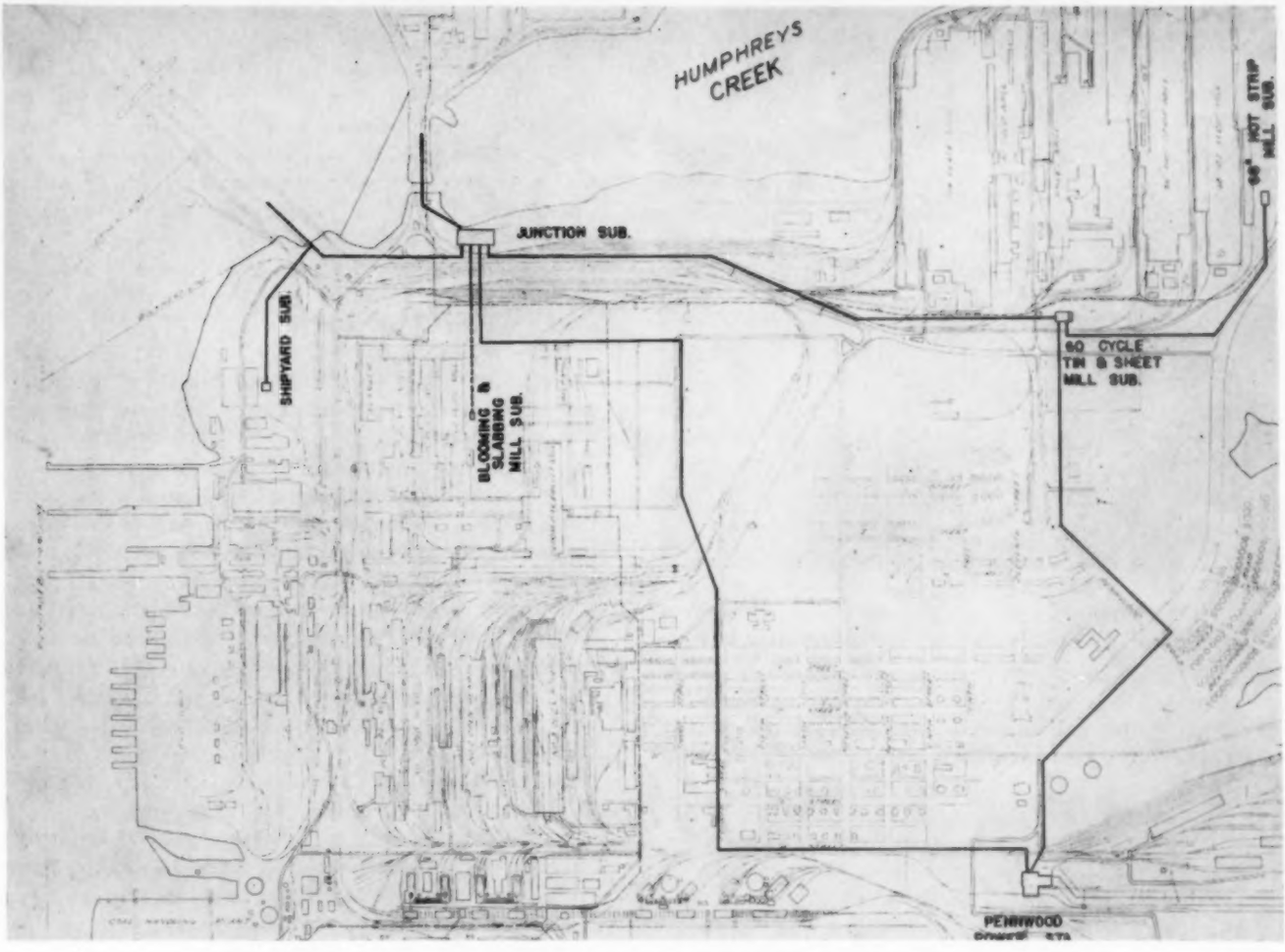


Figure 8 — Eventually, the 34.5 kv system illustrated will be installed in the plant.

when the first unit was started up. At that time the other unit was under construction, and both instances were due to errors of the construction forces.

Training of operating crews was started well in advance of the completion date, and it is felt that every dollar so invested has been returned many times over.

PENNWOOD POWER STATION DATA

Boilers—Two type V-3 boilers of 400,000 lb per hr continuous rating on blast furnace gas, 26,780 sq ft heating surface. Design pressure 1025 psi, operating pressure 900 psi at super heater outlet. Bubble type steam washers. Furnace width at tubes 25 ft. Sq ft furnace area, 9600. Front to rear 24 ft, width 25 ft.

Economizers—Two economizers, one gas pass, gas flow is down, water flow is up. 28 tubes wide, 14 tubes high, 2 in. outside diam tubes, 0.165 in. thick. Four headers. Heating surface 11,274 sq ft.

Air Preheaters — Two tubular air preheaters, gas through tubes air over tubes. Four passes of air over elements. Tube size 2½ in. outside diam. Number of elements 2900. Length of elements, 24 ft. Total heating surface, 45,500 sq ft. Divided flow to provide stoker air or gas and oil burner air. Air outlets connected by by-pass ducts and dampers to permit control of stoker air temperature.

Turbines—Two A.S.M.E. Standard 30,000-kw single case, impulse-reaction type, condensing steam turbines. Steam conditions: 850 psi at 900 F and 1.5 in. Hg absolute exhaust pressure. 3600 rpm, maximum steam flow, 302,000 lb per hr.

Condensers—Two surface condensers, 25,000 sq ft of

Figure 9 — Diagram of electrical connections.

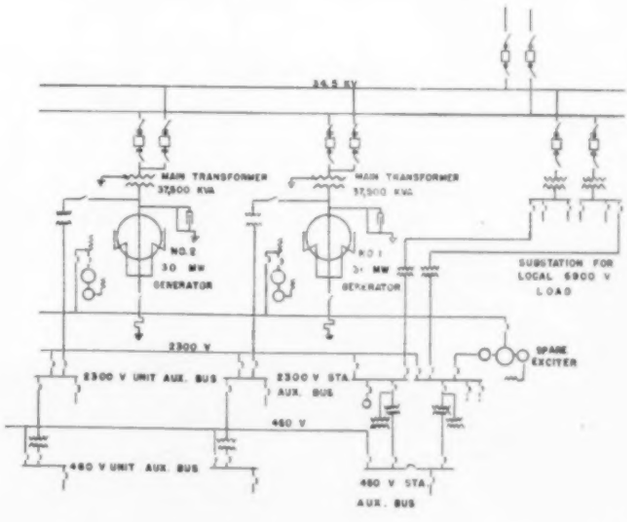


Figure 10 — A canal makes a supply of 370,000 gpm of water available for condensers and mill service pumps.

Figure 11 — Steam, gas, fuel oil, air and make-up condensate are carried in overhead lines.

Figure 12 — (below) Model of Pennwood Power Station.

effective surface, single pass, radial flow type, with divided water boxes, welded copper bearing steel sheets, deaerating hotwell and standard bronze metal tube plates. 4650 cupro-nickel tubes, ⅞ in. diam, and 24 ft long. 240,000 lb of steam per hr, 45,000 gpm of cooling water, temperature of water 70 F, 1.56 in. Hg absolute pressure 92.97 F temperature of condensate water.

Generators—Two 35,294 kva, 0.85 power factor, 30,000 kw, 3600 rpm, 0.8 short circuit ratio, 3-phase, 60-cycle, 13,800-v, hydrogen cooled self-ventilated generator, with shaft mounted fans.

Boiler Feed Pumps—Three horizontal split case 6-stage volute centrifugal pumps. Discharge head, 1225 psi, positive suction head, 30 ft, capacity 1000 gpm, water temperature at inlet 230 F. Two are motor driven, and one is steam turbine driven.

Condensate Pumps—Four 2-stage horizontal centrifugal type, enclosed type impeller made of bronze. Capacity, 800 gpm, total head, 200 ft, rpm 875, hp 62, efficiency, 61 per cent. All motor driven.

Induced Draft Fans—Four double inlet (2 per boiler), fans. Cfm 170,000, temperature of air 480 F, static pressure 18 in. Speed, 845 rpm. Motor driven with hydraulic coupling.

Forced Draft Fans—Four single inlet, single width forced draft fans, 48,000 cfm, temperature 80 F. Static pressure 11 in, speed 1160 rpm, bhp 134, efficiency 70.75, vane controlled inlet. Motor driven.

Feedwater System — Feedwater will be heated through 3 stages of closed heaters and one No. 2 open type deaerating heater. Closed heaters receive steam from turbine bleed points at 158.6 psia, 63.6 psia, and 9.2 psia (at full load). Deaerating heater operates under 5-8 psi. Final feed temperature is 355 F.

Feedwater sources: Condensate make-up from turboblowers, condensers and turbo-generators presently installed in the plant. Also from deep wells located in the hot strip mill area, and from town water system. All to supply necessary make-up when bleeding large quantities of 275 psi steam to the plant.

Steam—Generally speaking, if turbines are loaded up, they will use 600,000 lb per hr of 850 psi steam, station auxiliaries 50,000 lb per hr, and 150,000 lb per hr of 275 psi steam bled to the plant.

Salt Water Pumpage—High pressure system operating at 157 feet head supplied by centrifugal pump, turbine driven, capacity 35,000 gpm, connected to existing plant system.

Low pressure salt water system fully supplied by two steam turbine driven centrifugal pumps, capacity 60,000 gpm each total head 88 ft, also one electric driven centrifugal pump with impeller sized to pump 35,000 gpm at 88 ft with casing design to carry an impeller large enough to pump 60,000 gpm as the turbine driven units are designed.

Fuels Fired and Steam Flows—Boilers are provided to burn blast furnace gas, coke breeze, and oil. On blast furnace gas alone, output is 400,000 lb per hr steam. On coke breeze only, 200,000 lbs per hr steam. Oil only, 225,000 lb per hr steam, normally to provide necessary burner turndown. Capacity on oil may reach 450,000 lb per hr with other burners. Blast furnace gas and coke breeze combinations, maximum of 425,000 lb per hr steam. Firing all fuels in combination may reach 450,-

000 lb per hr if in proper proportions. Damper type superheat control.

Combustion Control Systems — Controls air operated, with three sources of air to Pennwood Station.

Soot Blowers — Sequential air operated, program controlled.

Dust Collectors—Two tubular dust collectors, twin design with 950 tubes. Dampers of the louvre type to maintain maximum efficiency of collectors at varying loads and type of fuels fired.

DISCUSSION

PRESENTED BY

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JOHN J. ALEXANDER, Assistant Superintendent Power Department, Republic Steel Corp., Cleveland, Ohio.

J. M. SPENCER, Assistant Fuel Engineer, Bethlehem Steel Co., Sparrows Point, Md.

W. N. Flanagan: The statement made by Mr. Spencer concerning Sparrows Point plant applies to most integrated steel works. Between the depression and the war, few plants have been able to completely catch up with fuel and power programs. Yet the average integrated plant can utilize all by-product fuels and still invite economy by affording a place for any savings due to improved operations. A steelworks can generally utilize its own by-product fuels and generate its own power more economically than it can purchase substitutes. For example, a completely integrated steel works producing a complete range of products requires for 2,000,000 net tons of product (approximately one-half the size of Sparrows Point) the following:

	Per year	Per day
Ingots	2,860,000 Net tons	7,860 Net tons
Iron	2,290,000 Net tons	6,280 Net tons
Coke	2,050,000 Net tons	5,620 Net tons
Coal	3,000,000 Net tons	8,220 Net tons

Electric power maximum requirements	Per day	Per hour
Kwhr	1,780,000	80,000 Kw average weekday
Peak kw		100,000 Kw high hour

The daily fuel produced in million Btu per day is as follows:

Coke oven gas	44,000	52,000
Tar	8,000	
Blast furnace gas	69,000	80,000
Coke breeze	11,000	
Total	132,000	

Most plants will use less power.

The daily fuel requirements will be:

	Blast furnace gas and breeze	Coke oven gas, tar or oil
Coke oven battery underfiring	17,500	2,500
Blast furnace stoves and misc.	17,200	.....
Blast furnace blowing	6,900	.....
Steel works operations and finishing	900	65,000
Sub-total	42,500	67,000

(Continued)	Blast furnace gas and breeze	Coke oven gas, tar or oil
Balance left for power and steam	43,550	—15,000
Required for plant steam	22,000	
Less steam produced by open hearth waste heat	—9,000	
Net fuel to steam	13,000	.....
Net fuel available for power	30,550	.....
Required for electric power (Average week day hour) (New station at 13,000 Btu per kwhr)	25,000	.....
Surplus	5,550	—15,000

The foregoing balance indicates a slight surplus of blast furnace gas which could be used for assisting the metallurgical fuel deficit. In most plants not all of the power equipment is new and not all mills are motor driven. Therefore, even this surplus is non-existant. A 28 ft 0 in. blast furnace provides fuel for 34,000 kw ±.

The heat rate of the new Sparrows Point station is approximately 12,300 Btu per kw apparently.

While many plants do not immediately have as favorable a blast furnace gas balance as indicated because of power blast furnace stoves and blowing equipment—lower recovery of open hearth waste heat, etc., the trend is in this direction.

Therefore the decision to generate their own electric power at Sparrows Point appears to be a wise one.

Even in plants which do not have a surplus of blast furnace gas, the cost of the marginal power is relatively lower than usually obtainable elsewhere.

*Present maximum investments	Investment per kw	Annual charges
The cost of a new 60,000 kw power house	$200.00	$0.00326
The cost of adding 60,000 kw to an established warehouse	150.00	0.00244
The cost of installing a larger power house or addition	100.00	0.00163

Operating Costs

At 70 per cent load factor

Kwhr per year per kw installed = 8760 x 0.70 = 6132.00 kwhr

Fixed charges:

Depreciation	4 per cent
Local taxes	3 per cent
Interest	2½ per cent
	9½ — say 10 per cent

*Many plants built in recent years cost less than these figures, which represent December 1948 construction costs. The trend apparently is turning.

Since the blast furnace gas and coke breeze would otherwise be wasted or else require a commensurate investment for economical use it is assumed that the value of fuel is zero.

The total costs are (assuming coal at $0.30 per mm Btu):

Cost of power house per kw	$200.00	$150.00	$100.00
Fixed charges	$0.00326	$0.00244	$0.00163
Operating costs	0.00075	0.00075	0.00020
Fuel	0.00000	0.00000	0.00000
Total	$0.00401	$0.00319	$0.00183

Assuming purchase power at $0.0085 per kwhr.

Annual savings at 6132 kwhr	$27.60	$32.40	$41.00
Gross returns, per cent (No federal taxes)	13.8	21.20	41.0

This indicates that while the return on the initial power house is reasonable, the return on additions and/or the decision to install larger units pays very attractively.

If the last block of power is produced from coal, the above becomes:

Cost of power house per kw	$200.00	$150.00	$100.00
Fixed charges	$0.00326	$0.00244	$0.00163
Operating cost	0.00076	0.00076	0.00021
Fuel at 13,000 Btu at $0.30	0.00390	0.00390	0.00390
Total	$0.00792	$0.00710	$0.00674
Annual saving at 6132 kwhr	$3.56	$8.60	$11.40
Gross return, per cent	1.8	6.7	11.4

The selection of pressure and temperature was a wise one. It enabled the purchase of a standard turbogenerator, which offers the lowest cost per kva and at the same time is in the trouble free range with no unknowns to cause outage or require development.

In the past many poor installations have been made in firing blast furnaces gas over stockers. The factors generally were:

1. Poor furnace design.
2. Lack of water walls.
3. Dirty blast furnace gas.
4. Too high air preheat on stokers.

The Sparrows Point plant seems to have all of these factors under control. There is only one item which may prove insufficient, that is gas cleanliness. In view of the low cost of obtaining cleaner gas (in the average plant) and the large investment at hazard, I would recommend closer to 0.01 grains per cu ft instead of 0.08.

The installation in question compares in many ways with one now being installed at South Works, Carnegie-Illinois Steel Corp., except that the South Works plant consists of one 60,000 kw preferred standard turbogenerator and one 650,000 lb per hr boiler. Pressure and temperatures are the same.

The one boiler—one turbine plant has been the subject of much controversy in power plant circles. With modern boiler reliability it becomes a question of what fraction the unit is of the total power system. Economics show 20 per cent higher investment for two units. If the unit in question is only about 20 per cent of the total system, I believe the choice is sound. Each of the Sparrows Point units appear to have about the same ratio to total plant load as the large South Works unit.

One of the most sensible as well as the most striking features of the Sparrows Point design is the installation of economizer, air preheater, dust eliminator, induced draft fans and stack flues out of doors. It has always caused embarrassment to some of our best engineers to be compelled by convention (sometimes by geography) to provide building space (at a cost) for tremendous amounts of static heat releasing areas that have no real need for this treatment and which make the boiler house more uncomfortable inside. The designers are to be congratulated.

I am also very glad to see fans on ground level instead of on the roof. The roof type construction may be warranted when real estate sells by the square foot instead of by the acre, but only exceptional conditions warrant its use in a large industrial plant.

The air preheater design is unique. Preheated air is desirable for not only the gas, but also coke breeze which generally carries a high percentage of moisture. The stoker air must be limited to between 250 and 350 F to prevent adherence of clinker and rapid deterioration of the grate surfaces.

The dust eliminator is also unusual in being capable of being by-passed when gas only is burned.

In connection with the plant heat balance, I agree with the use of only three of the five extraction stages of turbines of this size. I also feel that the use of low pressure 275 psi steam for station auxiliaries is economical. High pressure steam merely adds to the cost of the auxiliary turbines, without substantially improving economy, as the high temperature units generally fail to utilize fully the superheat.

While we have some damper controls operating satisfactorily, for most high pressure turbine drives, I prefer the external type backed by ample superheater capacity so that there will be no drop in superheat when changing suddenly from blast furnace gas to coal, coke or oil. The external control is less sluggish and is out of the path of the gases, but unless either type is backed by ample superheater surface, steam temperature drops up to 100 F may be experienced.

In closing I would appreciate hearing from Mr. Spencer his development of justification for the water treating plant for the low pressure boilers. I favor such an installation but would still appreciate some support. Also why were Muntz metal tube sheets used with cupronickel tubes. Why not a harder tube sheet metal?

John J. Alexander: Mr. Spencer has presented an excellent description of the power station. The discussion of equipment performance and the outline of operating faults is beneficial to all concerned.

His statement regarding the advantage gained by training operating crews well in advance of the completion date should be emphasized. I am certain this practice is not only sensible and necessary for safety, but that it is also economical. A well trained operating crew is as essential as a well designed and properly installed plant. An outline of the plan and duration of the training program for power station operating personel would be of interest if Mr. Spencer can provide this information.

Secondly, as equipment was placed in operation, were tests conducted to determine whether the performance of equipment was equal to each manufacturer's expectation? Was the station heat balance test results equivalent to engineering design performance data?

Is coke breeze fired as a base load fuel or as an auxiliary fuel to supplement blast furnace gas? If fired as an auxiliary fuel, how is underfiring or overfiring (or gas

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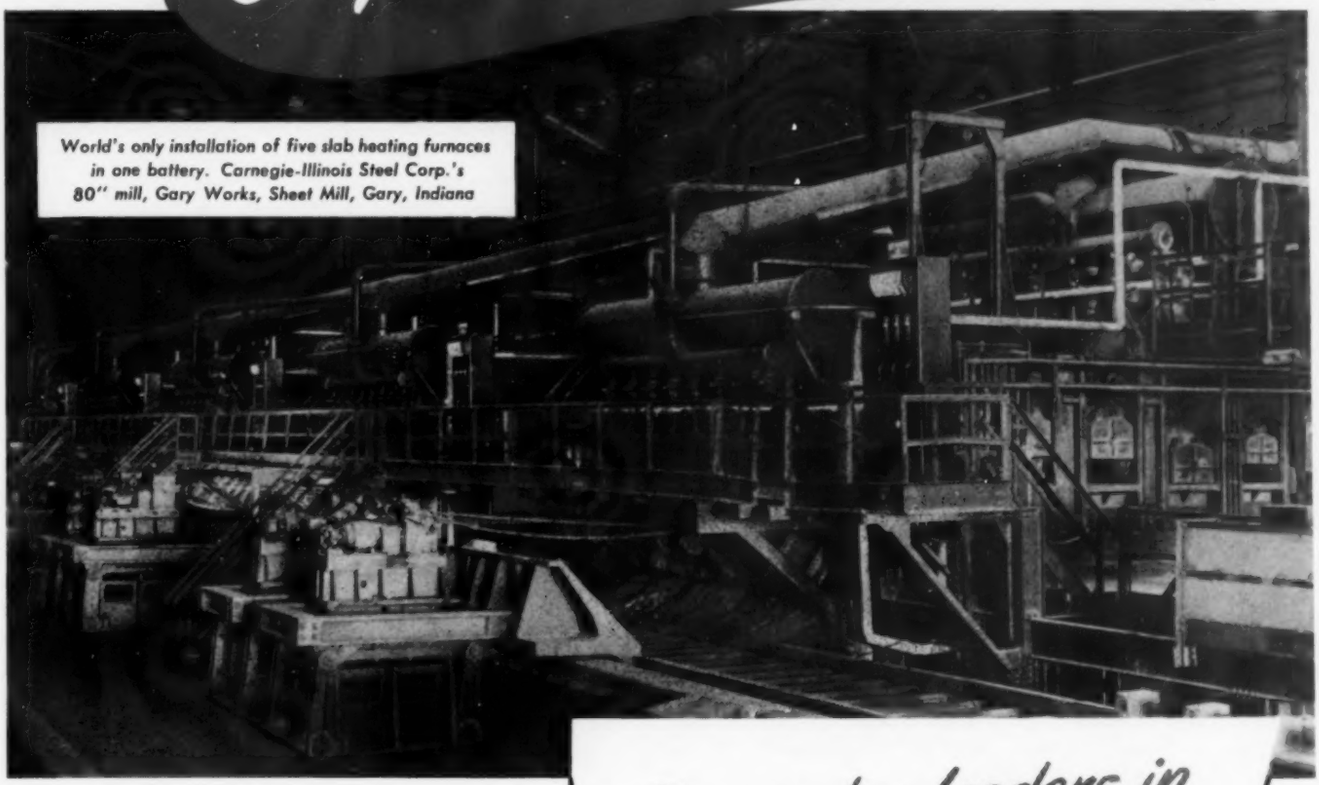

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bleed) prevented when abrupt changes in blast furnace gas volume occur?

J. M. Spencer: Mr. Flanagan's comments were of particular interest to me. I will not attempt to cover all of them; I will pick out a few points and answer those.

The gas-dust loading we have is rather fortuitous. We did not expect to get 0.03. We have operated a number of other units, 250 lb units, with dust loadings in the vicinity of 0.06 or 0.08. However, as pointed out, we did do what we could to get the gas-dust loading down without putting in disintegrating equipment, and I feel we have been very fortunate.

He also asked about the justification for the water-treating plant on the low-pressure units. Of course, the water-treating plant existed before this powerhouse was built. What we have done is to use condensate for make-up at this plant, and increase the amount of water handled by the existing water-treatment plant.

The existing water-treating plant is very simple. It consists primarily of aeration for removal of CO_2 and the oxidation of the iron contained in the water to FE_3O_4, so we can remove it by settling. That, primarily, is the water-treatment equipment. The rest of it is taken care of by internal treatment. Of course we were forced into this some years ago; we had quite a few accidents because of scale in a number of units. When the problem was attacked and followed up, the availability of the units increased quite a bit.

Several years ago we made a compilation of the larger 250-lb units to determine the availability. It was at the time the power study was in progress for this plant and, if I recall correctly, the availability was over 95 per cent.

Mr. Flanagan also asked why we used Muntz metal and cupro-nickel tubes. The only reason I can give for that is that we have used those materials satisfactorily in other units and decided to use them again on these particular units, because they had worked out very well.

Mr. Alexander has asked about the training program. We started with the thesis that, if we had good foremen, first-class foremen, we could run the plant with indifferent personnel. Of course we did not plan for any such personnel, but we realized we might have to put up with it.

Eighteen months before the plant went into operation, we started a training program for the foremen. It consisted of class two hours a week, training on the job in our other boiler-house, a short period on combustion control. They were required to sketch and describe the various systems and the various stations on which they worked. They were required to absorb a certain amount of theory on the equipment with which they were concerned.

It has worked out very well. To my knowledge, we have had no major operating errors, and I can only think of one instance which could be considered as an operating error.

The training of the other men was started approximately nine months before the station went into operation, and we did essentially the same thing, with the exception that they were given very little of the theory, primarily because they do not have the background, to begin with.

Mr. Alexander also asked about acceptance tests. We have had no formal acceptance tests. We have, of course, checked the major pieces of equipment to see if their performance is in line with the manufacturers' guarantee, and I believe they all have been. I do not think we will go to any formal acceptance tests.

On the question of coke, coke is used as an auxiliary fuel to fill in for low blast-furnace gas periods. Of course, in the multiple fired units, we can burn all three fuels in any combination. Actually, the way it has worked out is that when the gas furnace blast availability decreases the stoker feed and the air flow is increased, the stoker response is not enough to follow the load. Therefore, part of that load is followed with oil until the stoker can come up and hold; then the oil automatically goes off.

In regard to the overriding which he asked about, blast furnace gas availability to the boilers is determined by gas main pressure. At a predetermined pressure the gas is partially removed from each unit and is progressively removed as the gas main pressure falls. If the gas main pressure should fall to a dangerous low, the gas is shut off entirely.

Of course these are not the only units consuming blast furnace gas.

Mr. Alexander asked about the high gas period, I believe. Sudden increases in the gas main pressure are taken care of by automatically controlled burning bleeders.

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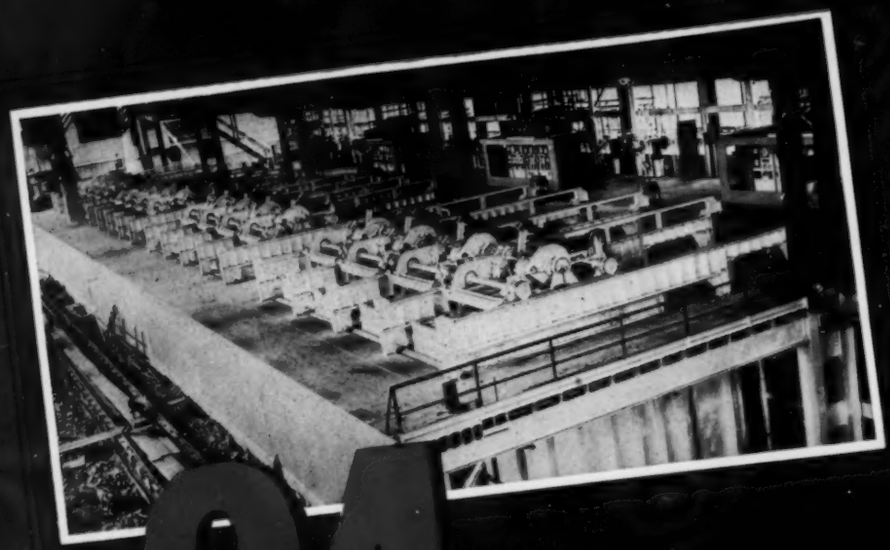

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NATURAL GAS
Gives Flexible Combustion Control

By W. A. STERMER
Industrial Engineer
The Manufacturers Light and Heat Co.
Washington, Pa.

▲ Natural gas is depended on for two important tasks in the efficient production of stainless steel strip and sheet at Washington, Pa. The Washington Steel Corp. produces "Micro-Rold" stainless steel strip and sheets in widths up to 36 in. and in a gage range from 0.004 to 0.078 in. Nominal capacity is 1200 tons per month, based on the cold reduction to 24-gage of hot-rolled stainless steel strip purchased from outside sources. A 39-in., cluster-type Sendzimir cold-rolling reversing mill rolls the stainless steel strip to minute tolerances with extremely close control of gage throughout width and length. The mill has a maximum speed of 400 fpm.

Natural gas, supplied by The Manufacturers Light and Heat Co., is the selected fuel for heat treatment. Annealing of the strip is accomplished either before, after, or as an intermediate step in the rolling process. Annealing equipment at Washington Steel consists of a 40-ft catenary-type continuous furnace. Strip in motion through the furnace is supported by rolls at furnace entrance and exit. The furnace is direct-fired through its sidewalls, above and below the strip. Multiple low pressure proportioning burners are used. Such burners provide combustion atmosphere control. Fuel input and temperature are regulated by a potentiometer recorder-controller system operating automatic valves. This furnace is operated in a temperature range from 1950 to 2125 F, depending on the gage or speed of the strip.

Natural gas is also used in the descaling process. The stainless steel strip moves directly from heat treatment to pickling. Scale removal equipment consists of two 40-ft tanks and one 20 ft tank allowing either electrolytic or acid pickling. Heat for the pickling solutions is furnished by steam from a 50-hp vertical tube gas-fired boiler. This boiler, equipped with automatic pressure and safety controls, is fired by proportioning type burners.

Both the annealing furnace and the boiler are equipped for emergency oil use. Cost of fuel oil operation is substantially higher in the present fuel market. Therefore, operation on oil is limited strictly to emergencies.

According to one Washington Steel official, the flexibility of gas for obtaining varied, predetermined combustion atmosphere, with the resultant control of scale characteristics, is particularly advantageous in their processing.

The fuel requirements of the process, with natural gas, when operating 18 turns a week are 3680 cu ft of 1050 Btu gas per ton processed. Gas is not measured to individual units. It is estimated, however, that 3100 cu ft of gas are required for annealing and 580 cu ft for processing steam.

Figure 1 — Exit end of the 40-ft catenary type continuous annealing furnace at Washington Steel Corp., Washington, Pa. Note the natural gas and air lines connected to low pressure, proportioning type burners at the sidewalls. Successive coils of strip are fed into this furnace from the far end. A pay-off pit, hidden by the furnace, gives space for slack and time to weld the feed of a new coil without changing speed of strip through the annealing process.

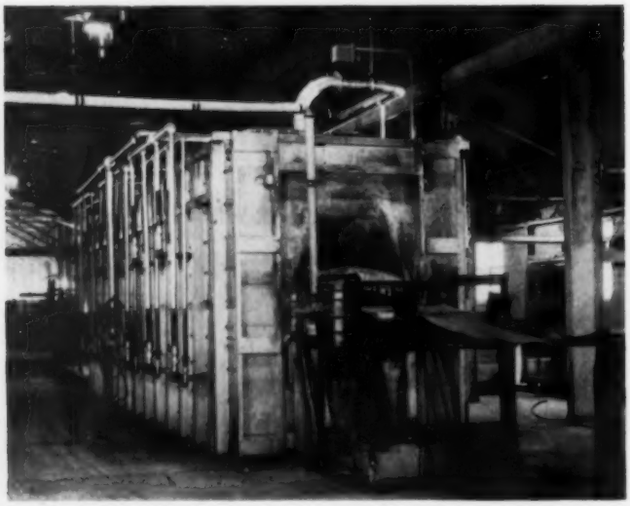

Figure 2 — The new Sendzimir cold rolling reversing mill at Washington Steel Corp., Washington, Pa. has a design speed of 400 fpm. The roll housing inspection door is swung aside to show the work and back-up rolls. Space in this plant has been arranged so that this mill, or any other equipment, can be duplicated without production stoppages.

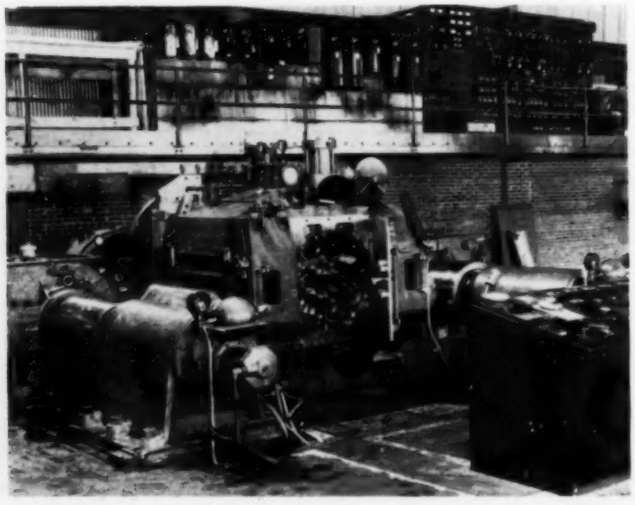

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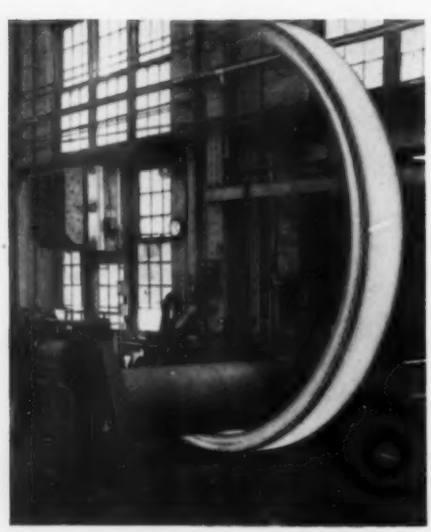
Figure 1 — Slab is shown leaving heating furnace prior to rolling.

Figure 2 — Rolling is done in mill with two working rolls on bottom and one working roll on top.

Figure 3 — Slab is shown starting third pass through mill.



▲ The welded products division of General Electric's large motor and generator divisions at Schenectady, N. Y., produces the stator frames for many of the divisions' motors and generators as well as for many of the giant steam-turbine generators. The accompanying figures illustrate the steps in the manufacturing process by which they are fabricated to specified shape and size — the hot rolling story.

Figure 1 shows how 36-ft-deep furnace heats steel slabs for rolling. Slabs are placed on a bed similar to a railroad flat car which travels in and out of the furnace on a track. After the heating period (depending on the size of the slab), the door is opened and the car moves out. Slab temperature is 1100 C or 2012 F.

Figure 2 shows craneman and crane followers swinging hooks into place — gripping either side of the slab approximately in the middle — and moving the slab into position between the rollers. The man at the right directs the rolling, his helper is at the left, and the control man can be seen in the background.

The steel slab, still glowing white hot, is shown in Figure 3 about to start through the rolls for a third pass. The two bottom rollers are power driven to carry the slab, and the top roller adjusts vertically to bring pressure on the piece and shape it. With each trip back and forth between the rollers, the slab bends gradually into its specified form.

After a number of passes, the curvature of the slab is measured for uniformity by means of a template as shown in Figure 4.

In Figure 5, the man is shown checking the diameter of the piece. When the correct diameter is reached, the frame is removed from the rolls to the cooling floor.

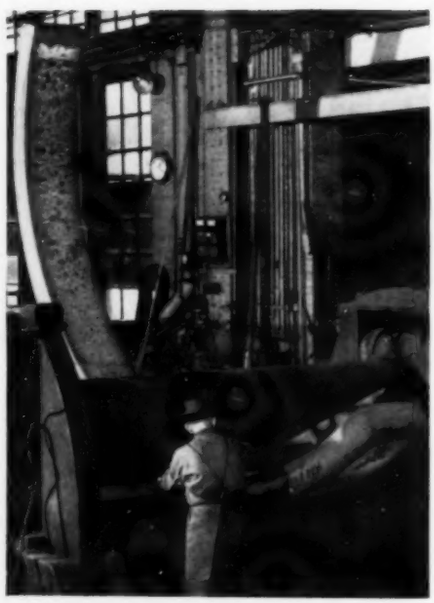


Figure 4 — Skill is required by the operator to obtain uniform curvature of the slab.

Figure 5 — Final product is a semi-circular piece.

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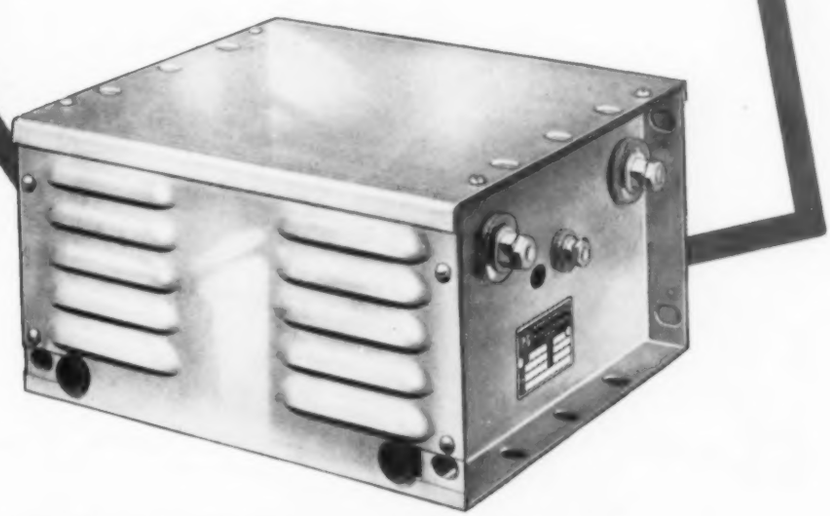

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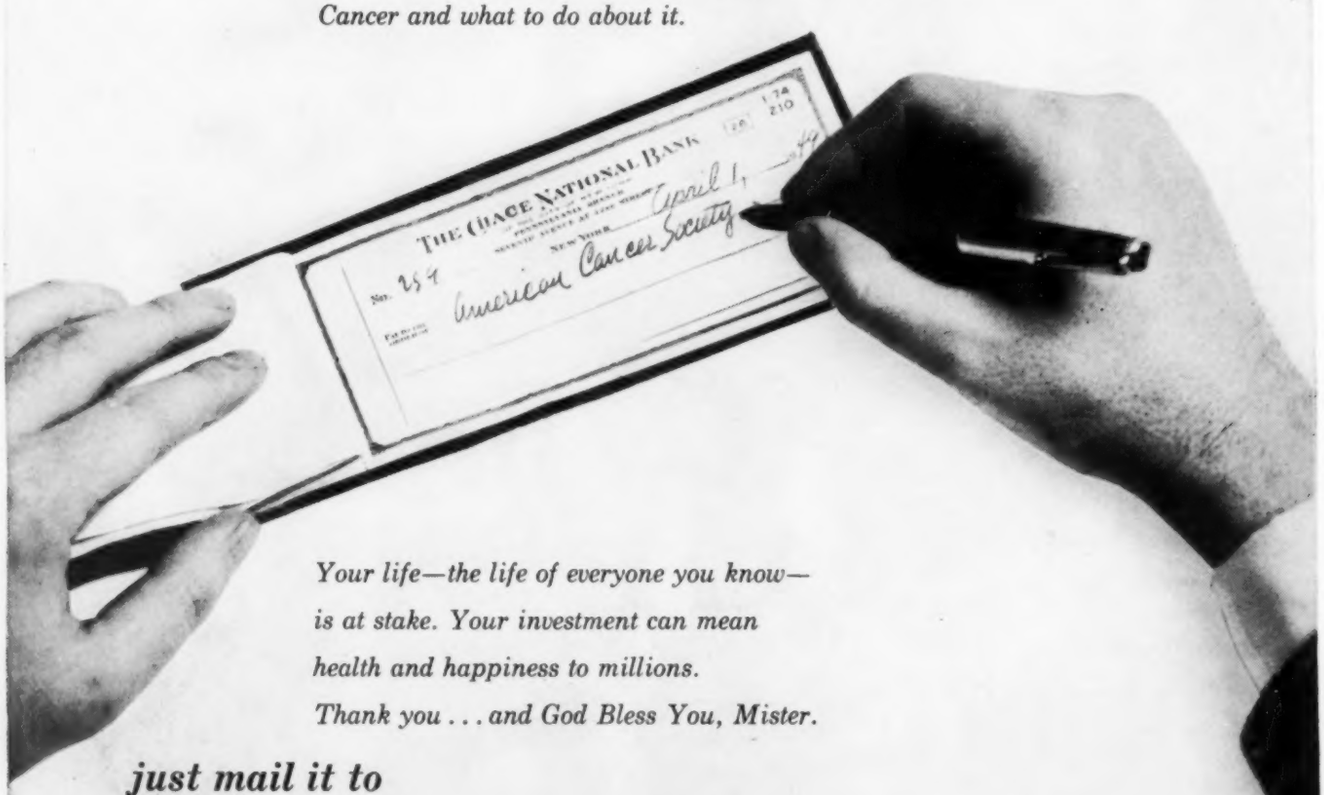

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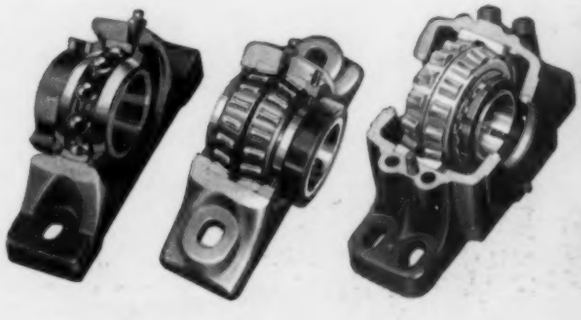

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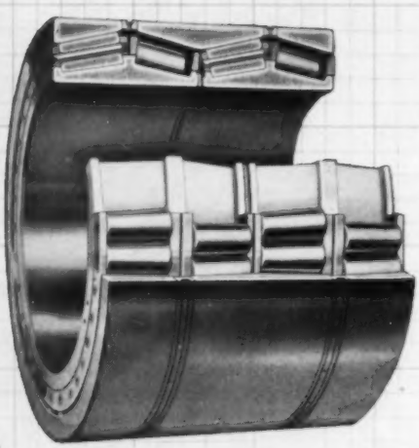


It takes bearings with rugged construction and sound metallurgy to keep roughing stands operating continually. In the rougher and other stands in Carnegie-Illinois Steel Corporation's 80" hot strip mill at Gary Sheet and Tin Mill, Torrington Roll Neck Bearings provide these and other advantages.

Four rows of tapered rollers provide high radial and thrust capacity. The reduced cross-section of these bearings allows larger roll necks for maximum rigidity. Minimum friction allows rapid acceleration with improved quality and uniformity of gage of sheet.

These Torrington Roll Neck Bearing features add up to economical operation, greater production and lower maintenance. Specify Torrington Bearings for your mill stands and auxiliary equipment.

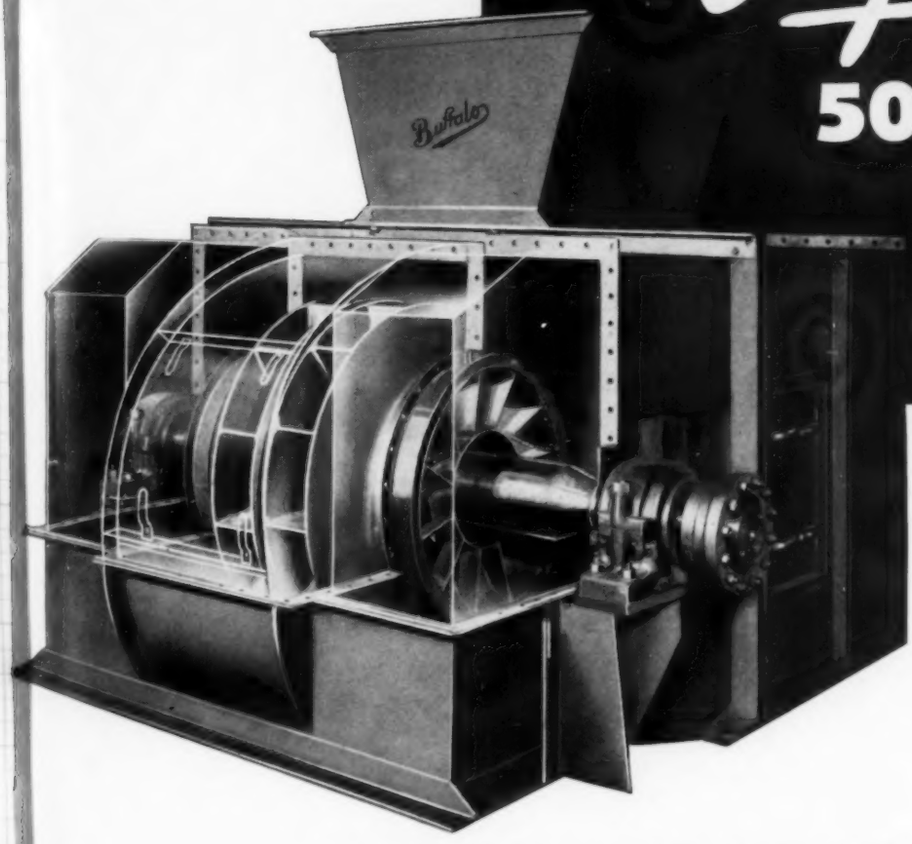
THE TORRINGTON COMPANY
South Bend 21, Ind. • Torrington, Conn.
District Offices and Distributors in Principal Cities
of United States and Canada

TORRINGTON *TAPERED ROLLER* BEARINGS

SPHERICAL ROLLER · TAPERED ROLLER · STRAIGHT ROLLER · NEEDLE · BALL · NEEDLE ROLLERS

Capacity:

50,000 C.F.M. AT 83" WATER PRESSURE



"Buffalo"

TYPE "CC" and "CB" PRESSURE BLOWERS

AN EXAMPLE OF THE HIGH PRESSURES

"Buffalo" **OFFERS IN SINGLE STAGE BLOWING**

The "Buffalo" Centrifugal Compressor shown above is a type "CC" Double Inlet model. In this "CC" class, "Buffalo" offers you a range of capacities from 4000 to 75,000 c.f.m. at up to four pounds pressure per square inch. The type "CB" blowers handle static pressures from ¾ lb. to 2¼ lb., at moderate volumes. All rotors are dynamically balanced and capable of standing tip speeds far higher than regular operating speeds. Side plates and housings are rib-stiffened. WRITE FOR BULLETIN 3553-A for any pressure blowing need you have.

Type "CB" Blower with side plate removed. Note convenient access to all parts.

"Buffalo" FIRST FOR FANS

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173 Mortimer St. BUFFALO, NEW YORK

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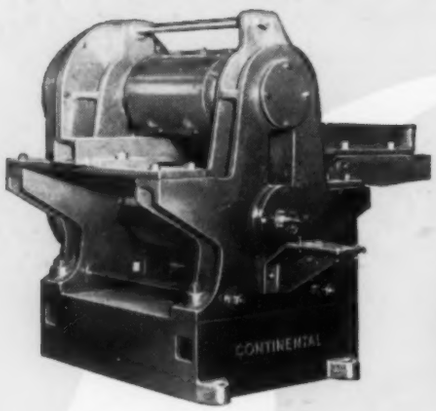
VENTILATING FORCED DRAFT | AIR WASHING COOLING | AIR TEMPERING HEATING | INDUCED DRAFT EXHAUSTING PRESSURE BLOWING

Continental
AUXILIARY
MILL EQUIPMENT



Cropping and Dividing Shear

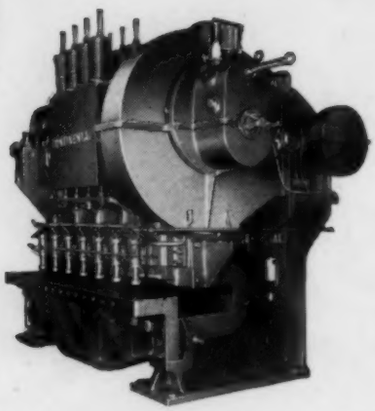
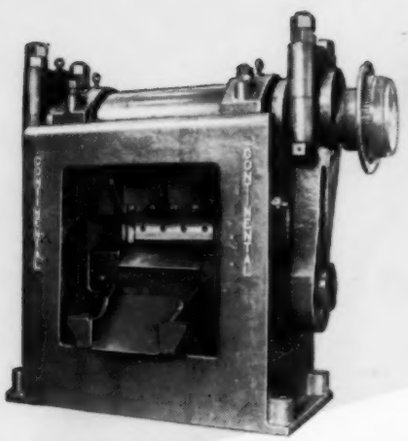


Plate Shear



Upcut Bloom Shear

PRODUCERS OF: Complete Rolling Mill Installations including:

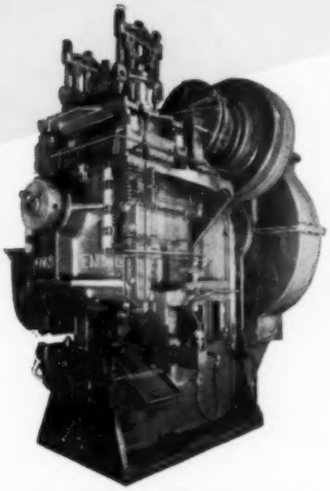
Blooming Mills	Plate Mills	Non-Ferrous Mills	Tables
Structural Mills	Slabbing Mills	Roll Lathes	Transfers
Bar Mills	Universal Mills	Ingot Mold Cars	Shears and other auxiliary steel plant equipment
Billet Mills	Hot Strip Mills	Charging Box Cars	
Merchant Mills	Cold Strip Mills	De-Pilers	

IRON, ALLOY IRON and STEEL ROLLS for ferrous and non-ferrous rolling mills; pulp and paper industry; textile industry; and milling, cereal and vegetable oil industries.

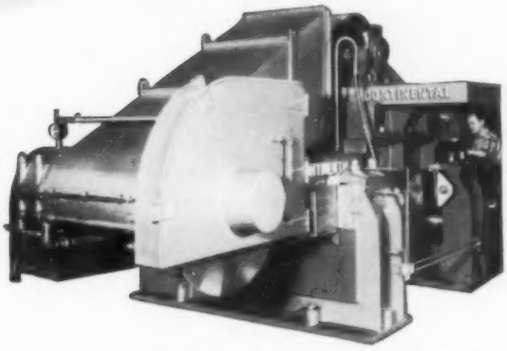
CARBON and ALLOY STEEL CASTINGS from 20 to 250,000 pounds. Complete heat treating and machining facilities.

Downcut Slab Shear and Gauge

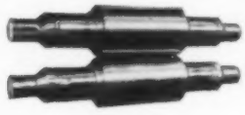
Straightening Press



Tie Plate and Splice Bar Punch and Shear



Heavy Duty Hot and Cold Saw



ROLLS
Iron, Alloy Iron and Steel

STEEL CASTINGS
20 to 250,000 Pounds

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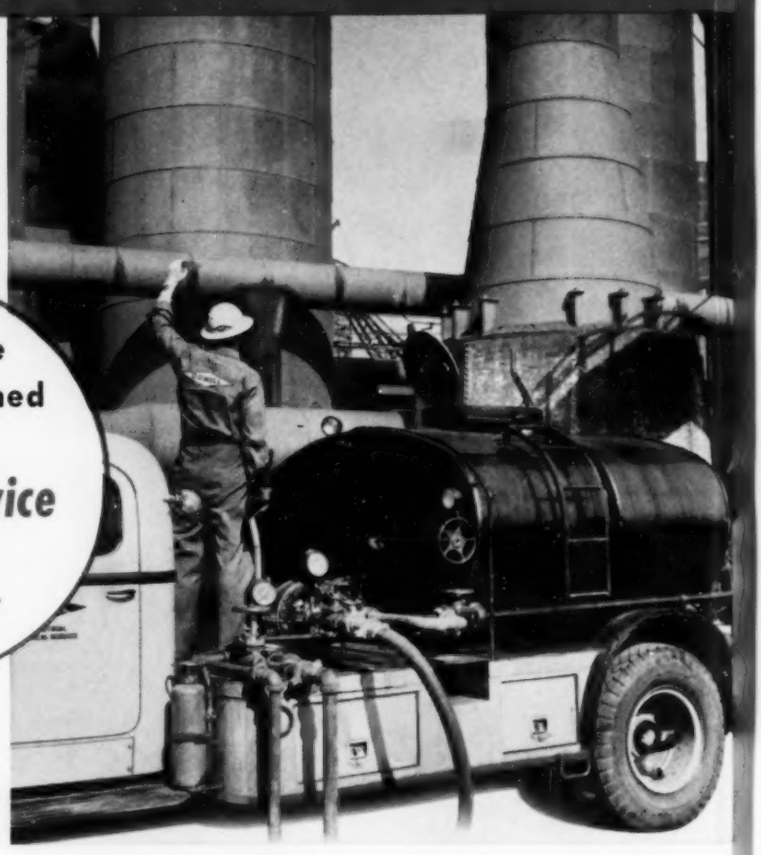
Plants at: East Chicago, Ind., Wheeling, W. Va., Pittsburgh, Pa.

DOWELL

SERVICE SPECIALISTS IN MAINTENANCE CLEANING PROBLEMS

No Shut Down for Cleaning!

Full Furnace Wind Maintained While *Dowell Service* Cleaned Gas Washer



A blast furnace gas washer was operating with 23″ of water pressure drop while scrubbing 60,000 cu. ft./min. of blast furnace gas. Cleaning was imperative. *In two hours,* Dowell Service reduced the pressure differential of the washer to a normal of 7″ of water. The furnace top pressure had fallen from 60″ to 40″. At no time during the cleaning was it necessary to reduce the wind or in any other way interrupt gas washing operations!

Dowell Service, using the experience of thousands of successful jobs, offers you the solution to maintenance problems of this kind. It is backed by strong, continuous research programs, both in Dowell's own laboratories and in those of The Dow Chemical Company. This research provides the means for a constantly improving service with an ever increasing degree of effectiveness and safety.

Dowell engineers have effectively cleaned many other types of steel plant equipment including furnace cooling systems, pipe lines, precipitators, coke plants, cooling jackets and power generation equipment. In all cases costly down time has been held to a minimum. No special scaffolding or extensive dismantling is required for Dowell Service. The special liquid solvents are pumped into the equipment through existing connections.

Call the nearest Dowell office for more details and free estimates on the cost of cleaning your equipment.

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Philadelphia 2	Detroit 2	Houston 2	Salem, Illinois
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Wilmington 99	St. Louis 8	Ft. Worth 2	Midland, Texas
Richmond 19	Indianapolis	Shreveport 69	Wichita Falls, Texas
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Buffalo 2	Kansas City 8	Mt. Pleasant, Mich.	

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DOWELL

A SERVICE ORGANIZATION

Date-line Diary...

July 3

▲ Allegheny Ludlum Steel Corp. is planning to borrow $12,000,000 to finance their new $23,600,000 plant improvement program. The remainder will be financed from their own funds. Among improvements planned are new hot strip mill and cold rolling facilities.

▲ The Bureau of Labor Statistics predicts new construction for this year will total almost $26,000,000,000 for a new high.

▲ Based on reports from companies having 94 per cent of the steel capacity of the industry, the operating rate of steel industry is scheduled at 92.6 per cent of capacity for the week beginning July 3, 1950. This is equivalent to 1,765,200 tons of steel ingots and castings compared with 1,929,100 tons one week ago.

July 5

▲ SEC reported that United States corporations built up their working capital to a record high of $69,000,000,000 on March 31, or an increase of $1,300,000,000 since the beginning of the year. Corporations spent $3,400,000,000 on plant and equipment during the first quarter.

▲ Shipments of iron ore over the Great Lakes from Lake Superior region during June totaled 11,737,924 tons. Total movement so far is below last year.

July 6

▲ The National Steel Company of Brazil announced that rolled steel production will reach 308,000 metric tons this year.

▲ American Railway Car Institute reported that domestic freight car deliveries in June totaled 3,874. Orders during June totaled 2,195 and the backlog as of July 1 was 40,585 which is slightly less than one year ago.

July 7

▲ Scrap prices dropped to $40 a ton.

▲ International Nickel Company set up a plan in which it will allocate sales of nickel to customers.

▲ A walkout on four of the five western railroads was terminated last night. The strike still continued against the Rock Island.

July 9

▲ Employment in the iron and steel industry reached the highest level of the year in May according to the AISI with a figure of 628,200. Total payroll in May was $199,905,000. The average hourly payments were $1.722 and the work week averaged 39.7 hours.

▲ The Edison Electric Institute reported that electric utilities set new high records in sales and earnings in the first half of 1950. Net income was estimated at $448,000,000 for this period.

July 10

▲ Based on reports from companies having 94 per cent of the steel capacity of the industry, the operating rate for the week beginning July 10 is scheduled at 96.0 per cent of capacity. This is equivalent to 1,830,000 tons of ingots and castings compared with 1,765,200 tons one week ago.

▲ The Oliver Iron Mining Company announced that large scale iron ore shipments are scheduled to start today for eastern mills by rail instead of by lake shipments.

July 11

▲ The British Iron and Steel Federation reported that Great Britain made more steel in the first half of 1950 than ever before. Total output was 8,309,000 tons.

▲ The Agriculture Department reported that the 1950 corn crop is estimated at 3,176,000,000 bu, or 21 per cent over the production goal.

▲ Soft coal operators in Pa., W. Va. and Ohio formed a permanent organization to bargain with the United Mine Workers. This organization, the Bituminous Coal Operators Association, will be headed by Harry M. Moses.

July 12

▲ The Senate Finance Committee dropped proposed legislation reducing excise taxes because of the Korean situation.

▲ House Ways and Means Committee approved a bill to suspend the copper import duty of 2¢ a lb until next June 30.

▲ Lead prices advanced ½¢ a lb to 11½¢ in New York.

▲ Dominion Foundries & Steel authorized the issue of 80,000 shares of a sinking fund preferred stock to provide additional capital for building a blast furnace and coke oven plant in Hamilton, Ontario.

July 13

▲ Price of lead advanced ½¢ a lb to 12¢ a lb in New York.

▲ According to the Federal Reserve Board, industrial production in June was the greatest since the war, or 197 per cent of the 1935-1939 average.

▲ The Engineering News Record reports that engineering construction awards for the week ending July 13 totaled $364,000,000 a new peace-time high.

July 14

▲ Department of Commerce reports that wages and salaries paid American workers reached a record annual rate of $139,200,000,000.

▲ The Donner-Hanna Coke Corp. is planning to build 36 coke ovens at a cost of $1,000,000 at its Buffalo plant.

▲ The American Gas Association reports that gas companies plan to spend $1,006,000,000 for new construction in 1950.

▲ The government of Venezuela has given the United States Steel Corp. authority to proceed with a $200,000,000 development of its iron ore deposits. U. S. Steel plans to move its iron ore from the mines by 40,000-ton sea-going ships which will require extensive dredging of the river.

July 17

▲ Based on reports from companies having 94 per cent of the steel capacity of the industry, the operating rate of steel making furnaces is scheduled at 99.4 per cent of capacity for the week beginning July 17, 1950. This is equivalent to 1,894,800 tons of steel ingots and castings compared with 1,830,000 tons one week ago.

July 19

▲ AISI reports that expansion plans of steel industry will increase steelmaking capacity 6,363,000 tons by the end of 1952, when total capacity is expected to reach 105,750,000 tons. Capacity of the industry on July 1 passed the 100,000,000 ton mark when a new figure of 100,563,500 tons was established.

▲ The Aluminum Association reports that primary aluminum production in May was 123,858,511 lb, the highest since the end of the war.

▲ Irving S. Olds, chairman of United States Steel Corp., reports that the corporation plans to increase capacity in the Chicago and Pittsburgh districts by 1,660,000 ingot tons by fall 1951. Construction of the steel plant in Trenton, N. J. will also start in 1951 and will also have a minimum ingot capacity of 700,000 tons annually.

▲ The Reynolds Metals Company increased the price of aluminum pig and ingot 1¢ a lb to 17½¢ for pig and 18½¢ for ingots.

▲ President Truman asked Congress for $10,000,000,000 to help finance additional required defense expenditures.

July 20

▲ Allegheny Ludlum Steel Corp. reported that new sales and

earning records were set in the first half of 1950. Sales totaled $78,288,590 and earnings totaled $4,571,171.

▲ No. 1 heavy melting scrap rose $1 in the Pittsburgh district to $41 a ton.

July 21

▲ The F. W. Dodge Corp. reports that construction awards in the 37 states east of the Rockies was $1,345,463,000 or less than 1 per cent below the all-time monthly record.

▲ The House-Senate Economic Committee urged that tax increases be established at once on corporations and individuals.

▲ The Reynolds Metals Co. announced that it had rescinded a 1¢ a lb price increase on aluminum because of President Truman's plea to hold prices down.

▲ According to Ward's Automotive Reports, automobile production in the remainder of the year will be restricted by shortages, and the industry's goal of 6,600,000 passenger cars will probably not be reached.

▲ Machine tool orders in June were the highest since May 1945.

July 22

▲ Consideration is being given to the possibility of merging the Follansbee Steel Corp. and Newport Steel Corp., thus the cold rolling facilities of one company will tie-in with the hot rolling capacity of the other.

July 23

▲ The Industria Argentina de Aceros S. A., Buenos Aires, is purchasing a continuous butt weld pipe mill and wire drawing facilities.

July 24

▲ Based on reports from companies having 94 per cent of the steel capacity of the industry, the operating rate of the steel industry is scheduled to be 99.3 per cent of capacity for the week beginning July 24, 1950. This is equivalent to 1,892,900 tons of steel ingots and castings compared with 1,894,800 tons one week ago.

▲ The Pittsburgh Coke and Chemical Co. raised prices of pig iron $3 a ton. As a result basic is selling at $49.

▲ Independent Petroleum Association of America estimate that the oil industry needs 2,842,200 tons of steel annually for oil and gas exploration and development.

July 25

▲ The Department of Commerce revised their estimate of 1949 income to $216,800,000. The revised gross national product figure was $255,500,000.

▲ President Truman asked for an increase of $5,000,000,000 on corporations and individual income taxes.

▲ Commerce Secretary Sawyer asked Congress to give the president power to allocate vital materials.

▲ United States Steel Corp. reported record earnings for the first six months of 1950, with a total of $119,079,238 or $4.08 a share compared with $3.12 for the first half of 1949. Shipments of steel products for the first six months totaled 11,248,427 tons.

July 26

▲ The AISC reported that June bookings of fabricated structural steel were estimated at 266,531 tons, the highest since April 1942. Shipments totaled 162,343 tons and the backlog for the next four months is 579,583 tons.

▲ German Steel Export Committee reported that American firms are placing large orders for steel from west Germany as a result of the Korean war.

▲ The Crucible Steel Co. and the Remington Arms Co. are forming a jointly owned company to produce titanium metal and metal alloy products.

▲ Inland Steel Co. reports that net income for the first six months totaled $21,463,754 or $4.38 a share, a record first half earnings. Sales for the first half were $208,688,831.

▲ Jones & Laughlin Steel Corp. announced that revenues for the first six months of 1950 totaled $219,627,068. Consolidated net income was $16,314,970 or $4.99 a share.

▲ Net income for the Youngstown Sheet and Tube Co. for the first six months of 1950 totaled $18,276,773 compared with $21,043,365 for the first six months of 1949.

July 27

▲ Kaiser Industries, Inc. last week filed a plan with National Security Resources Board by which the capacity of Fontana steel could be increased 700,000 ingot tons at a cost of $1,000,000.00

▲ The National Steel Co. of Brazil plans to expand capacity of Volta Redonda from 343,000 to 562,000 tons for ingots, and finished steel from 301,000 to 467,000 tons. Plans include a blast furnace, open hearths, rolling and finishing equipment. The Export-Import Bank plans a credit of $25,000,000.

▲ Generating capacity of private and public electric power agencies is slated to reach 67,526,000 kw by the end of 1950. This should be ample to meet all military requirements in case of full scale war.

▲ The General Motors Corp. produced 1,012,874 cars and trucks the second quarter of 1950 for a new record.

July 28

▲ Carnegie-Illinois Steel Corp. announced that it will rebuild two coke oven batteries, Nos. 13 and 15 at Gary, as well as revamp the stainless steel facilities in the sheet and tin mill.

▲ The AAR set up a program calling for the construction of 122,000 new freight cars at a meeting of 132 major roads in Chicago.

▲ The Commerce Department stated that new orders in June totaled $22,600,000,000, or $2,300,000,000 more than in May.

▲ National Steel Corp. reported net earnings for the first six months of 1950 of $29,048,806 or $3.94 a share compared with $3.51 a share in 1949.

▲ The Bethlehem Steel Corp. announced that net profits for the first six months of 1950 totaled $57,240,573 or $5.63 a share compared with $5.91 a share the same period in 1949.

July 29

▲ The Babcock and Wilcox Tube Co. put in production a new mill for producing electric resistance welded tubing at Alliance, Ohio. The product will range from ½ in. and up, in wall thicknesses of 20 gage and heavier.

▲ The Inland Steel Co. plans an increase in steel making capacity of 750,000 ingot tons through the construction of a new open hearth with four 250-ton furnaces. Capacity by early 1952 will be 4,500,000 tons.

July 30

▲ The Westinghouse Electric Corp. reported net income for the first six months of 1950 of $27,206,707 or $1.86 a share compared with $2.10 a share for the same period of 1949.

July 31

▲ Based on reports of companies having 94 per cent of the steel capacity of the industry, the operating rate of the steel industry is scheduled to be 100.7 per cent of capacity for the week beginning July 31, 1950. This is equivalent to 1,919,600 tons of steel ingots and castings compared with 1,892,900 tons one week ago.

▲ President Truman stated that he will accept standby wage-price-rationing controls if Congress approves them.

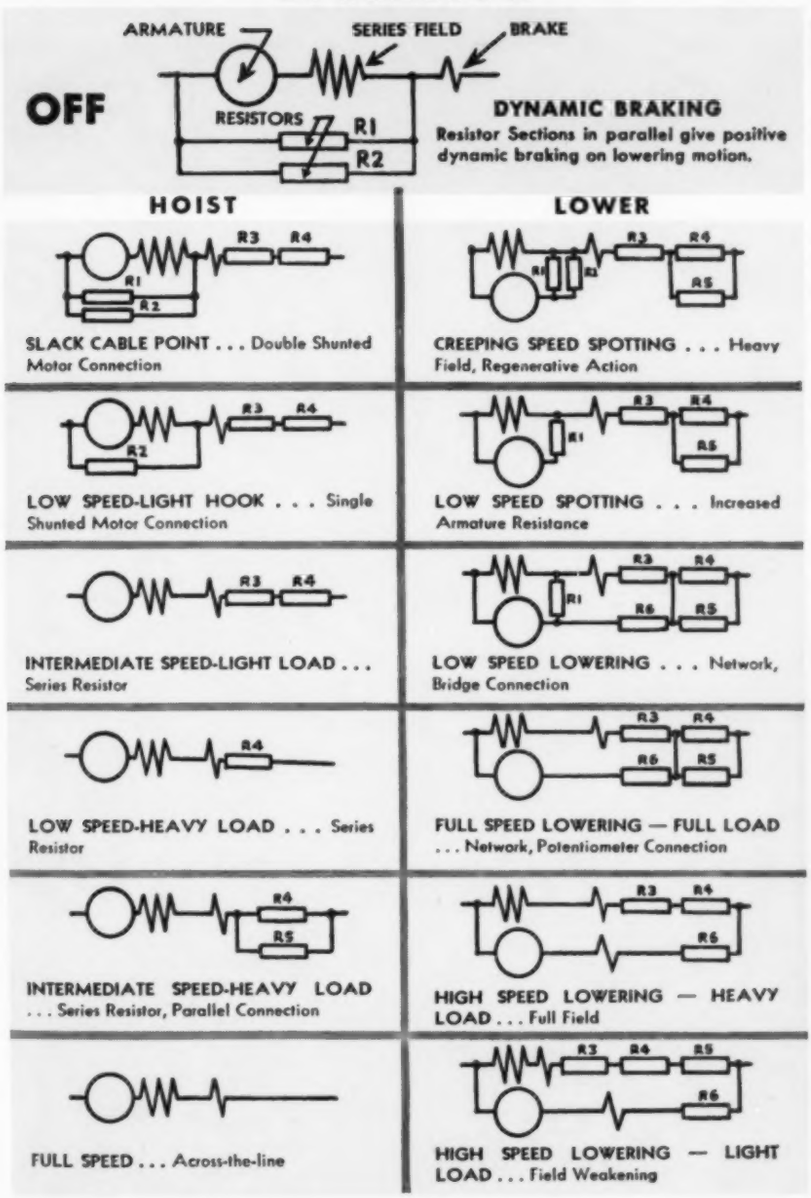
▲ Senator O'Mahoney asked for an immediate excess profits tax based on average corporation profits for 1947-49.

▲ The government sent letters of intent to four aircraft manufacturers telling them to start work on military planes for which formal orders will be sent later.

▲ R. W. Wolcott stated that the steel industry has now increased its purchases of high quality foreign scrap to between 400,000 and 500,000 tons.

New DYNAMIC LOWERING NETWORK SYSTEM FOR HOIST CONTROL

OPERATION


ARMATURE
SERIES FIELD
BRAKE
OFF
RESISTORS
R1
R2
DYNAMIC BRAKING
Resistor Sections in parallel give positive dynamic braking on lowering motion.
HOIST
LOWER
SLACK CABLE POINT . . . Double Shunted Motor Connection
CREEPING SPEED SPOTTING . . . Heavy Field, Regenerative Action
LOW SPEED-LIGHT HOOK . . . Single Shunted Motor Connection
LOW SPEED SPOTTING . . . Increased Armature Resistance
INTERMEDIATE SPEED-LIGHT LOAD . . . Series Resistor
LOW SPEED LOWERING . . . Network, Bridge Connection
LOW SPEED-HEAVY LOAD . . . Series Resistor
FULL SPEED LOWERING — FULL LOAD . . . Network, Potentiometer Connection
INTERMEDIATE SPEED-HEAVY LOAD . . . Series Resistor, Parallel Connection
HIGH SPEED LOWERING — HEAVY LOAD . . . Full Field
FULL SPEED . . . Across-the-line
HIGH SPEED LOWERING — LIGHT LOAD . . . Field Weakening

Safer. Two spring closed contactors and resistor sections in parallel insure positive dynamic braking on lowering motion.

More Control Over Hook. Double armature shunt makes slack cable and low speed—light hook points individually adjustable. Series relay provides for high speed lowering of heavy load with full field stability, and yet permits field weakening necessary for high speed lowering of light loads.

Reduced Maintenance. Network circuit is designed for low current peaks during motor acceleration. Maintenance is minimized on control contactors as well as on motor commutator and brushes. Only nine contactors are required for control system.

Class 7954 Dynamic Lowering Hoist Control Panel

Only nine contactors are needed to give better hook control with the new network system.

Write for descriptive Bulletin 7954. Square D Company, 4041 N. Richards Street, Milwaukee 12, Wis.

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Is PHYSICAL STRENGTH your magnet problem?

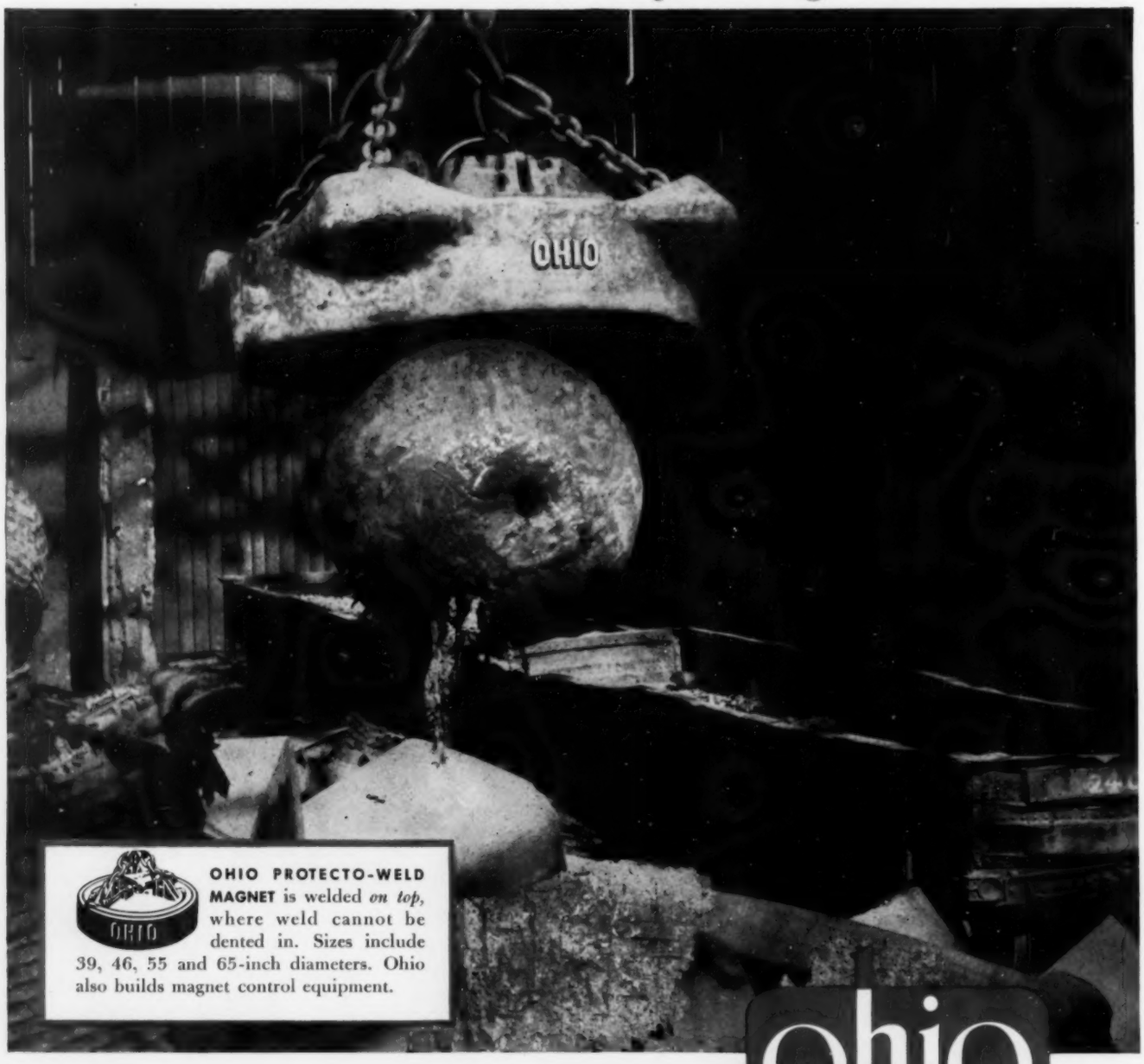
Mills agree that skull-cracking subjects a magnet to the roughest of service. Cautioning crane operators to "take it easy" is sage but frequently impractical advice.

Why not fit your magnet to the job when you buy?

Ohio *basket-type* magnets are specially constructed to withstand hard knocks. "Fenders" project beyond magnet diameter . . . stave off and protect against damaging blows.

For extra magnet life in rough service, install Ohio *basket-type* magnets. Write today to Ohio—25 years a leader in *magnetic materials handling.*

Use "basket" construction for rough service



OHIO PROTECTO-WELD MAGNET is welded *on top,* where weld cannot be dented in. Sizes include 39, 46, 55 and 65-inch diameters. Ohio also builds magnet control equipment.

THE OHIO ELECTRIC MFG. CO. • 5900 MAURICE AVENUE • CLEVELAND 4, OHIO

Ohio MAGNETS

Industry News...

U. S. STEEL TO INCREASE CAPACITY BY 1,660,000 INGOT TONS ANNUALLY

▲ United States Steel will increase its steelmaking capacity by 1,660,000 ingot tons annually through an improvement program to be instituted at the Pittsburgh, Pa., and Chicago, Ill., district plants of Carnegie-Illinois Steel Corp.

The new program will be pushed to completion as rapidly as possible, and should result in an increase of 1,215,000 tons in the annual steel capacity of United States Steel within a year. It is expected that the remainder of the program, now in the engineering stage, will make an additional 445,000 tons of annual productive ingot capacity available by the fall of 1951. The major part of the program will get under way immediately. The construction work connected therewith will not interfere with existing steel production.

This program for additional steel capacity, which can be installed in about half the time required for the construction of entirely new facilities, should prove to be of material help toward meeting the current high demand for many kinds of steel products. The additional capacity will result from the addition of improved facilities, as well as from certain alterations and rearrangement of existing equipment, and technological improvements.

The plants whose steel capacity is to be so increased are Gary and South works in the Chicago district, and Homestead, Edgar Thomson, Clairton, Duquesne and Ohio works (Youngstown) in the Pittsburgh district.

In addition, United States Steel plans to commence the construction in 1951 of the first parts of a new integrated steel mill on its presently owned site on the Delaware River south of Trenton, N. J., with a minimum ingot capacity of around 700,000 tons annually.

CONTINENTAL ESTABLISHES WELDMENT DIVISION

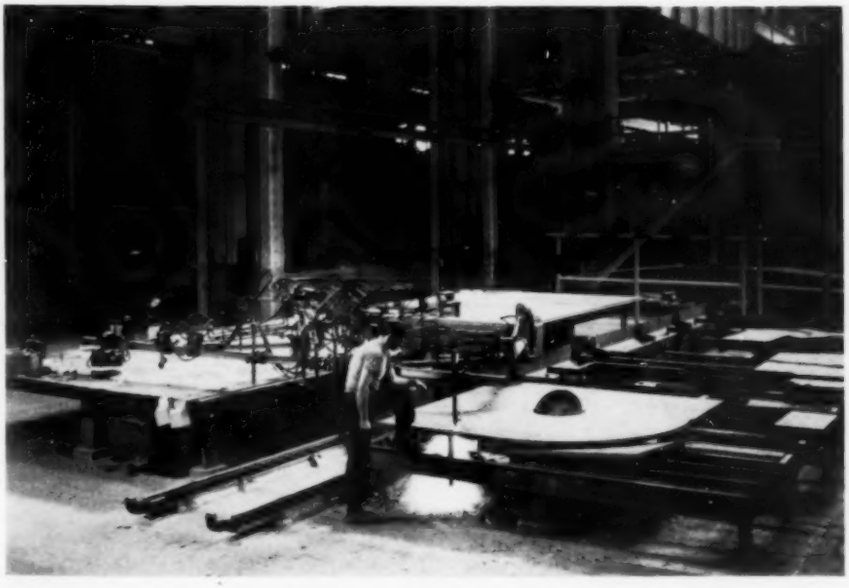
▲ For the first time in its 40-odd year history, Continental Foundry & Machine Company has entered commercial weldery as an adjunct to its steel foundry production and manufacture of complete rolling mills, heavy machinery and iron and steel rolls.

The building housing the new weldment division is one purchased less than a year ago as war surplus and was previously a cast armor plant operated by Continental throughout the war on ground adjacent to their East Chicago plant. The main purpose of the plant now is the production of fabricated steel and steel plate structures to effect economies in both weight and cost of intricate assemblies.

The addition of weldments to the firm's operations in no way limits its production of steel castings but would improve its competitive position by permitting production of assemblies by the most efficient method —either steel castings, steel plate fabrications, or composite assemblies —for commercial customers as well as its own product components.

The complete steel fabricating, welding and machining facilities now offered by Continental also open up new markets to the firm including formed and welded units for the chemical and refining industry, electrical industry, and certain machinery and heavy equipment industries not formerly served to any large extent. Continental is in a unique position to serve a wide variety of industries because its facilities include a complete engineering department, three complete steel foundries, a steel fabricating and welding division and one of the most comprehensive groups of machine shops in the industry.

The new weldment division is a complete steel fabricating shop with a well-equipped welding department.

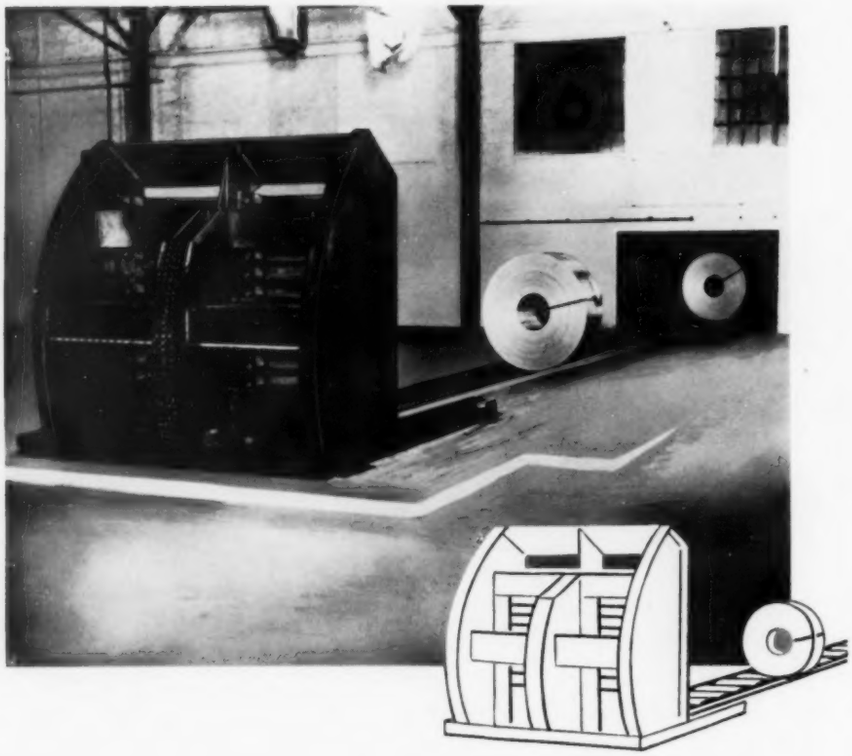


STEEL FABRICATING AND WELDING SHOP

The new weldment division is a complete steel fabricating shop with a well equipped welding department that is capable of handling any type of welding—almost without size limit.

The heavy steel fabricating shop is equipped to handle steel plate one inch thick and heavier and operations on plate as heavy as 10 to 12 in. In this shop, paper templates are used exclusively for all plate shape cutting. This eliminates the delay and additional cost generally connected with the use of burning templates of metal or wood. All irregular shapes in plate are flame cut with either the Airco Travograph or manually operated

Where equipment has to be *tough* to survive . . .



you'll find MATHEWS CONVEYERS

Conveying equipment going into heavy industry has to be rugged, or it won't be around for long. It must have the right stuff built into it if it is to stay on the job.

Mathews Engineers are specialists in the field of heavy conveying. Whether the loads are ingot mold flasks, coils of steel, or brass bars—whether they weigh one ton or twenty-five—handling them is an everyday job for Mathews Conveyers.

There is power or gravity equipment in the Mathews line that will do this heavy conveying with a minimum of costly maintenance. So, don't worry about your heavy conveying problems—give them to Mathews Engineers.

Engineering offices located in principal American and Canadian cities.

•

MATHEWS CONVEYERS

GENERAL OFFICES . . . . . *Mathews Conveyer Company*
ELLWOOD CITY, PENNSYLVANIA

PACIFIC COAST DIVISION . . *Mathews Conveyer Company West Coast*
SAN CARLOS, CALIFORNIA

CANADIAN DIVISION . . . . . *Mathews Conveyer Company, Ltd.*
PORT HOPE, ONTARIO

"turtleback" torches. The Travograph is capable of carrying up to eight torches and is operated automatically by an electronic tracing head which follows a paper template by electric eye. This facility alone is said to reduce by 80 per cent both the time and cost involved in template preparation plus attainment of greater cutting accuracy.

In this same shop is believed to be the world's largest press brake and one of the four largest existing plate bending rolls. The huge press brake exerts a rated pressure of 1000 tons and will accommodate a 16 ft plate between housings. The full width of the brake will take a 20 ft plate and will easily produce a 90 degree bend in one inch plate the full width.

Being primarily in the heavy machinery business, Continental has built its own plate bending roll and this, incidentally, is built largely from weldments produced in the very same shop. This bending roll will bend 14 ft wide, two inch thick plate cold to an inside diameter of 42 in.

The equipment in this shop also includes a plate squaring shear which will shear one inch plate in widths up to 12 ft.

The lighter steel fabricating shop is equipped in about the same manner but for the handling of ½ in. and lighter plate. This includes two 600 ton hydraulic presses, one a gap press with a 9 x 12 ft bed and a 600 ton side ram; the other a four post press with 8 x 4 ft between columns on the bed. There is also a 300 ton press brake which will bend ½ in. x 10 ft plate. Shearing capacity will handle ½ in. x 12 ft plate and a new plate bending roll is being installed which will bend ½ in. x 16 ft wide plate to a radius of 9 in. A new rotary shear will produce bevel cuts or shear to circular or irregular shapes on one inch or lighter plate. A punch press located in this department will punch 1½ in. holes in 1¼ in. plate. Radial drills complete this department.

MODERN WELDING EQUIPMENT

The welding shop provides a large bay for the assembly of fabricated units and is fully equipped with the most modern equipment. Three 10 ton electrically operated welding positioners are conveniently located

(Please turn to Page 142)

UNLIMITED KVA PROTECTION
for this 400 HP, 2300 Volt Synchronous Motor

Steel Mill Air-Compressor Installation

Nothing to Replace-No Calculations-No Change later on with EC&M VALIMITOR (Volt-Ampere-Limitor) Motor Starters

Simplified *short circuit protection* without a ceiling—because under a fault condition, the maximum fault current is limited to 25,000 KVA or less (steady state current). The well-known EC&M Type ZHS heavy-duty, magnetic contactor used in VALIMITOR Starters clears such faults quickly.

Because protection is *unlimited*—there's no need to calculate existing short circuit capability—no need to fear that these starters will be out-moded by future growth in KVA. And when a short occurs, there's nothing to replace—no spares to stock—no time out for replacement. To restart—just press the start button.

For purchasing simplicity, EC&M VALIMITOR Starters for 2300-4600 volt motors have no equal. Specify only horsepower-size, voltage, phase and frequency. EC&M VALIMITOR Starters give effective protection at all times—during starting, accelerating and running, *irrespective of KVA capacity* or *magnitude of fault*.

Write for Complete Facts— Ask for T9-117 Reprint Bulletin

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO

Koppers *has what it takes*

to build good coke oven plants!

IT TAKES a good basic design.

We believe the Koppers-Becker Coke Ovens have the best of all designs . . . sturdy, free from complications, simple to control, with the largest practical coking capacity. This design can be used over a wide variety of conditions, making metallurgical or domestic coke with heating by any kind of fuel gas normally available, and in large or small sized ovens. The ovens are accessible throughout; this means low maintenance and long life.

IT TAKES constant engineering refinement.

The number of coke oven plants which Koppers builds gives this company an unparalleled opportunity to develop new ideas to meet the new needs.

For example, the waste gas recirculation system was developed by Koppers to meet the need for greater coal carbonization capacity per oven. To produce more coke from ovens, it became necessary to make them greater in height. To get uniform heat in walls of very high ovens, when heating with coke oven gas, it was necessary to delay the rate of combustion. This has been accomplished with the waste gas recirculation system.

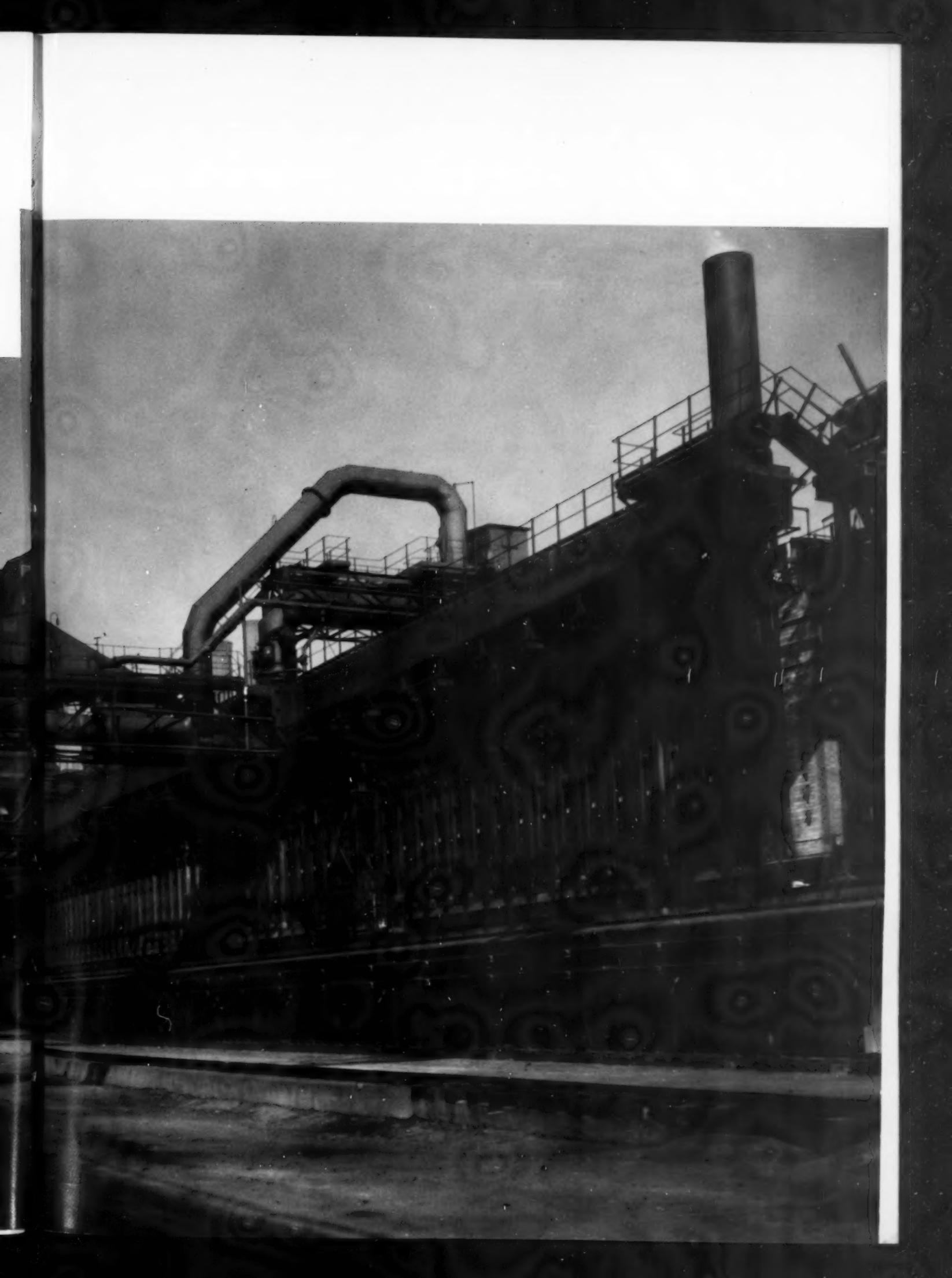
IT TAKES a fine engineering staff.

Koppers engineering staff has proved its ability to design and erect the most advanced and efficient coal carbonization, material handling and gas treatment equipment.

KOPPERS COMPANY, INC.

Pittsburgh 19, Pa.

KOPPERS **ENGINEERING AND CONSTRUCTION DIVISION**



(*Continued from page 138*)

for either manual welding or automatic submerged arc welding. The fully automatic submerged arc equipment can move its welding head through a 270 degree arc as well as having the usual vertical and lateral head movement. Comparisons of its speed are shown by records of weld deposits amounting to 25 to 30 lb per hr contrasted with 3 to 5 lb per hr done by hand. Further, due to the flexibility of this machine it is economical to produce series of extremely short welds while other methods frequently prove uneconomical on welds shorter than 3 to 4 ft. This equipment is augmented by numerous semi-automatic welding heads and the usual hand arc.

Two large shot blast cleaning rooms are in operation and plenty of stress relieving equipment is in evidence. This includes a large 12 x 20 x 45 ft pit type stress relieving or annealing furnace and a battery of 14 car bottom type furnaces 20 ft long with 10 x 10 ft openings.

Size and weight of product are almost without limitation in this new shop due to its spacious layout and heavy duty crane capacity. The building is 775 ft long and contains three bays having widths of 56, 52, and 72 ft respectively. A total of sixteen cranes serve this production area with the heavy fabrication bay being served by two 60-ton cranes on the same track. Loads of 150 tons or more can readily be accommodated by combinations of adjacent cranes.

X-ray facilities in an adjacent building provide 1,000,000 volt commercial equipment with complete laboratories. One of the largest heavy duty machine shops in the district is also in an adjacent building for precision finishing, and certain basic machining equipment is in the process of being installed directly in the weldment building.

INLAND STEEL INCREASES STEELMAKING CAPACITY

▲ Inland Steel Co. disclosed plans to enlarge its steel making capacity to 4,500,000 net tons of ingots annually from its present rating of 3,750,000 tons.

The company, which is the leading independent steel producer of the middle west, will construct a new open hearth shop with four 250-ton furnaces. It will be built on land already reclaimed from Lake Michigan beyond present buildings of its Indiana Harbor works in East Chicago, Ind.

Furnaces of this size are a maximum that can be efficiently charged and tapped with equipment presently available, officials said, adding that they would incorporate all modern improvements that steel making experience had developed.

Their design will enable further expansion by the subsequent addition of duplicate units as conditions warrant, it was added.

The new furnaces will be coordinated with present installations in a way to minimize the need of auxiliary facilities, the company said, although some equipment for handling materials and reheating ingots will be required.

Enlargement of some of the present open hearths will round out the 4,500,000-ton ingot capacity, officials explained. Continual improvements in the present shops brought capacity to 3,750,000 tons from a former rating of 3,400,000, they said. This

Browning Mill Type Cranes are built in accordance with A. I. S. E. specifications. They incorporate the types of motors and controls on which your mill or industry has standardized. This flexibility adapts your VRB crane *perfectly* to your needs. Only the finest materials are employed. Browning heavy duty cranes meet the most rigid demands and satisfy the most critical users. Our design, placing plenty of strength wherever needed, is the outgrowth of 48 years' experience in the crane industry.

"Built as you yourself would build them"

Write for our Bulletin "S".

VRB

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BOX 309, WILLOUGHBY (CLEVELAND), OHIO
Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes

3 Production Benefits from this Remarkable Instrument

1. Closer Combustion Control
2. Better Quality Control
3. Productivity Raised

The Cities Service Heat Prover Analyzes Combustion Atmospheres of Industrial Furnaces

Regardless of type or size of furnace, atmospheres vital to steel production are quickly, accurately and completely analyzed. With this one remarkable instrument it is easy to determine how much fuel is wasted, whether excess oxygen may be present to cause scaling and how much energy is wasted in uselessly heating excess air.

A complete line of petroleum products for the Metal Fabricating Industry including:

- Chillo Cutting Oils
- Trojan Greases
- Trojan Gear Oils
- Pacemaker Compressor Oils
- Pacemaker Hydraulic Oils
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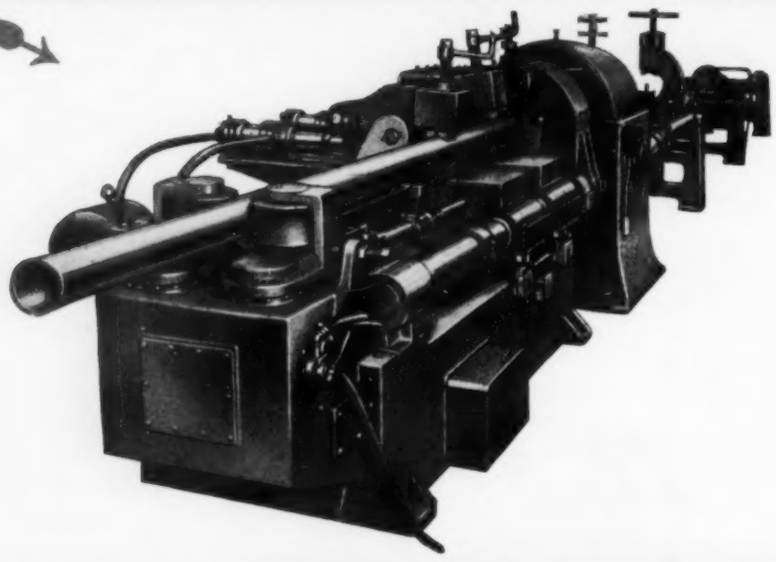
BAR & TUBE TURNERS

For speed...and for precision! Continuous, automatic feeding gives you high production unequalled by any other type of turning machine! For both rough peeling and finished precision conditioning, Medart Centerless Bar Turners will turn bars and tubes at maximum rate obtainable from any present day cutting tools. The machines are very flexible. May be used with one or two cutterheads, with one or up to eighteen tools in each head.

"Patents make Jobs"



MANUFACTURING ENGINEERS OF COMPLETE TRANSMISSION EQUIPMENT AND SPECIALIZED MACHINERY

MEDART

THE MEDART COMPANY - 3600 DE KALB ST., ST. LOUIS, MO.

was done, they said, by strengthening of buildings, improved material handling to and from furnaces, the addition of a new hot metal station and use of metallurgical oxygen also, larger pit cranes, together with larger steel ladles, have enabled the tapping of larger heats from existing furnaces.

With structural and material handling improvements already accomplished, several of the furnaces can be enlarged from 160 ton capacities to 200 tons, it was said.

The new open hearth shop will include a scrap yard, charging facilities, ingot mold yard and slag yard. Existing blooming mills will be equipped for the increased tonnage through the addition of new soaking pits and an elevated runway to speed the receipt of ingots from present open hearth furnaces.

No additions to blast furnaces or finishing mills are contemplated, the company said. Some increase in the capacity of existing strip mills is expected, however, from the building of an additional slab heating furnace, provision for delivering hot slabs to existing furnaces, and changes to produce larger coils.

The entire program should be completed and a 4,500,000 ton annual capacity attained early in 1952, Edward L. Ryerson, chairman of the company, told stockholders.

"It is our opinion that present equipment, augmented by the increased capacity, will give us increased efficiency at capacity operations and greater flexibility for any future period when our plants are operating at less than capacity," Ryerson said.

"We feel," Ryerson told stockholders, "that Inland must continue a healthy growth to maintain or better its position in the industry for the benefit of stockholders, customers, employees and the country's economy."

BUILD REFRACTORIES PLANT IN PORTAGE COUNTY, OHIO

▲ Harbison-Walker Refractories Co. announced the purchase of approximately 45 acres of land located at Windham, Portage County, Ohio, for the erection of a refractories plant to produce silica refractories.

The plant is designed for a starting capacity of approximately 20,000,000 nine inch brick equivalents annually. All features of design and equipment

incorporate the latest developments in the manufacture of silica refractories, and the plant will be strictly modern in every respect. The site is ideally located with respect to both rail and highway facilities.

It is contemplated that the first unit will be in operation within one year.

ALUMINUM ASSOCIATION CLARIFIES NOMENCLATURE

▲ To clarify the designation of aluminum sheet and plate, the sheet division of The Aluminum Association has adopted standard nomenclature for these products, Donald M. White, secretary, has announced.

The following definitions were adopted:

1. *Plate* is a solid section rolled to a thickness of 0.250 in. and heavier, in rectangular form with either sheared or sawed edges.
2. *Sheet* is a solid section rolled to a thickness range of 0.006 in. to 0.249 in., inclusive, supplied with sheared, slit, or sawed edges.
   a. *Flat Sheet* is furnished in rectangular form with sheared, slit, or sawed edges, which may be flattened by any standard method.
   b. *Coiled Sheet* is furnished in rolls (coils) with slit edges.

Heretofore, the terms "strip" and "coiled sheet" were applied interchangeably to the same product, but the new nomenclature officially recognizes the latter, more descriptive term.

KAISER CONSIDERING FURTHER EXPANSION

▲ Industrialist Henry J. Kaiser recently issued the following statement concerning expansion plans of the Kaiser industries: "At the Fontana, Calif., steel plant, we have just completed one phase of our program that has represented the investment of Kaiser earnings and working capital totaling more than 50 million dollars. This huge program has doubled the pig iron capacity of the west coast, opened up vast reserves of iron ore and coking coal, and added a broad range of steel products. Fontana is being operated to the limit of capacity, and still should be expanded more

PORTRAIT...

OF THE MOST EFFICIENT CLUTCH SERVING INDUSTRY...

Claims and counterclaims are constantly being made as to the relative efficiency of industrial clutches of all types.

If your industrial clutch problem can best be solved with an air clutch, investigate Fawick Airflex Clutches.

Fawick and only Fawick provides users with (1) 360° constant-velocity contact with the friction surface, (2) uniform-pressure axial contact between the full width of the friction surface and the drum, (3) unrestricted shock absorbing flexibility of the torque-transmitting rubber tube, (4) complete and sensitive torque remote control.

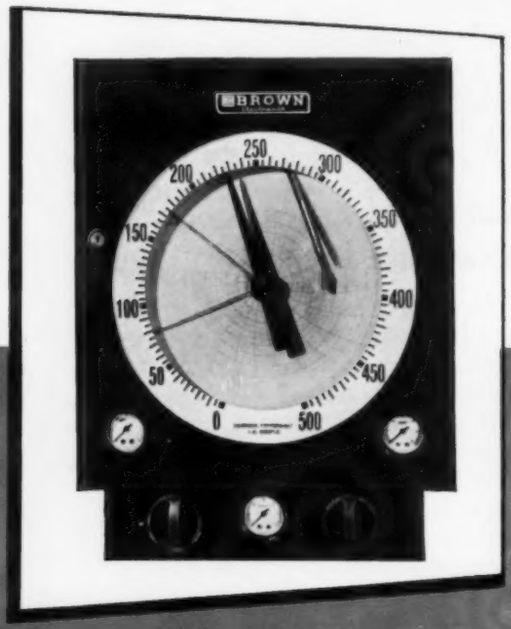
For specific information on all advantages of Fawick Industrial Clutch and Brake Units, write to the Main Office, Cleveland, Ohio, for Bulletin 300.

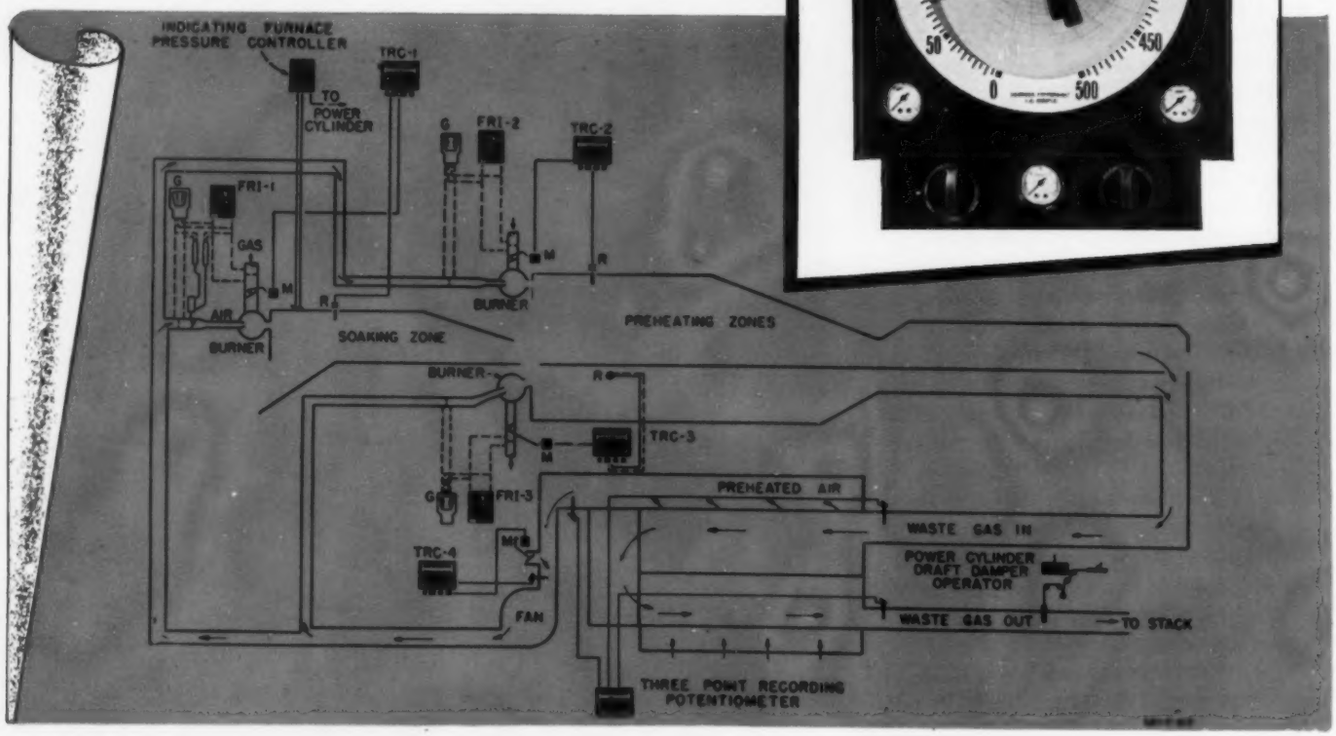
All desirable clutch characteristics are built into Fawick Airflex units

FAWICK Airflex CO., INC.
9919 CLINTON ROAD CLEVELAND 11, OHIO

FAWICK CLUTCHES = + + + = PEAK EFFICIENCY

Reap The Rewards of Optimum Reheating with the *ElectroniK* Air-O-Line CONTROLLER





Fast and uniform heating, less scale formation on the hearth, greater flexibility in case of mill delays . . . all are easily attained with the sensitive, accurate *ElectroniK Air-O-Line* Controller pictured above.

Featuring automatic reset, fuel supplies are rapidly established in accordance with the requirements of any charging rate for such precision applications as the one depicted in the diagram. Here, it adds new efficiency to the operation of a 3-zone billet or slab reheating furnace (over and under-fired preheat and over-fired soak) . . . utilizing the rapid speed of response of *Radiamatic* primary sensing units.

Increased quality and tonnage . . . as well as substantial savings in fuel, scale losses and furnace repairs . . . rapidly repay the initial cost of installing the *ElectroniK* Controller. Write for Bulletin 6.4-7 or call in your local Honeywell engineer for a discussion of its application in your plant . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4464 Wayne Ave., Philadelphia 44, Pa. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

VISIT BOOTH 314, 315, 316 AT THE IRON AND STEEL EXPOSITION, SEPTEMBER 26TH THRU 29TH, CLEVELAND, OHIO

MINNEAPOLIS **Honeywell**
BROWN INSTRUMENTS

to meet peace-time needs, let alone any defense requirements.

"Consequently, Kaiser Steel has a number of alternate expansion plans on which we have been working without letup. For example, one of the plans mentioned in Washington dispatches as being before the National Securities Resources Board and Munition Board sets forth the possibilities of expanding the Fontana plant 60 per cent for national defense purposes. It would enable the rapid increase of steel making capacity by 700,000 tons a year."

TURBO-BLOWERS INCREASE OHIO WORKS' PRODUCTION

▲ Production of blast furnace iron at Carnegie-Illinois' Ohio works, Youngstown, Ohio, will be increased by nearly 800 tons a day with the installation of two new turbo-blowers, which will replace present obsolete equipment. Work should be completed in about ten months.

To make room for the new equipment, two abandoned boiler houses which have been used for storage since 1936 will be torn down. U. S. Steel's American Bridge Co. will erect

HIGH-SPEED ROLLING MILLS SOLD TO FRANCE

Two large high speed rolling mill installations built by Loewy rolling mill division, Hydropress, Inc. for leading French companies are being shipped to Europe. They consist of two 4-high running-down cold mills and two 2-high finishing mills designed for rolling down of aluminum foil to minimum .00025 in. at a delivery speed up to 3000 fpm. Special electric controls, push button screw-down, methods of absorbing heat from strips and rolls, for accurate control of the roll crown, precision winding and unwinding reels were developed to obtain high quality at the highest production speed.

Jones

ROLLER BEARING PILLOW BLOCKS

JONES Pillow Blocks are made in sizes to take shafts 15/16" to 9" in diameter. Equipped with double row Timken roller bearings. Engineered and designed for the most efficient solution of your drive problems. Ask for Bulletin No. 86.

W. A. Jones Foundry & Machine Co.
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Since 1890
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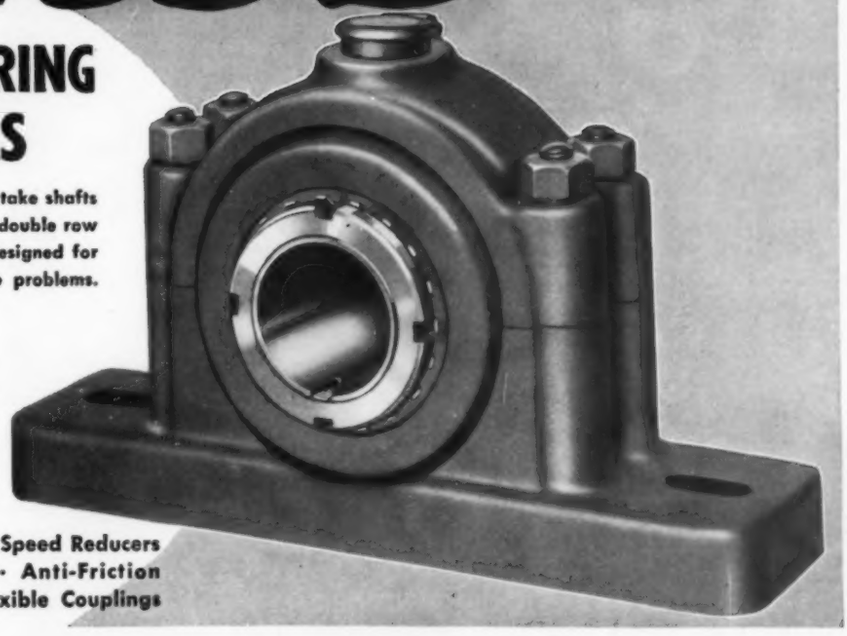
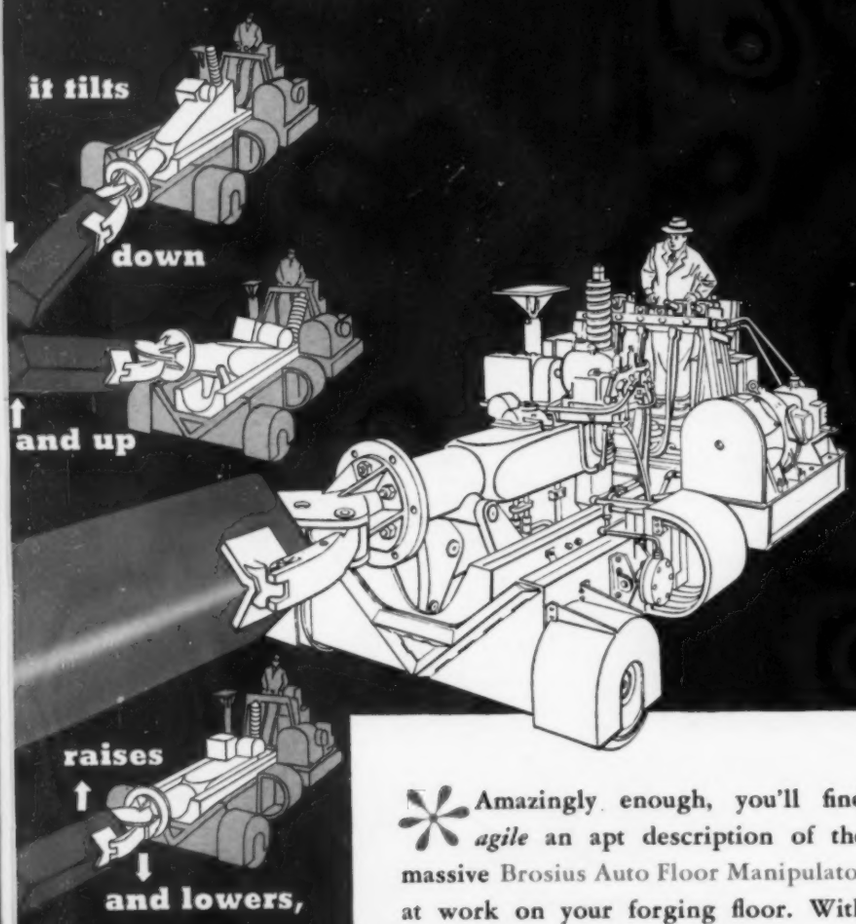
In the Service of Industry

Herringbone — Worm — Spur — Gear Speed Reducers
Pulleys · Gears · V-Belt Sheaves · Anti-Friction
Pillow Blocks · Friction Clutches · Flexible Couplings



agile*



*Amazingly enough, you'll find *agile* an apt description of the massive Brosius Auto Floor Manipulator at work on your forging floor. With swift agility it draws or charges — turns on a dime and moves with independent facility — manipulates the billet or blank with remarkably sensitive movements. And each unit possesses the inherent sturdiness and sensible simplicity so typical of Brosius products. Brosius manipulators will bring to your forge shop added speed, added safety, added economy — you should be using them. Write for literature.

Edgar E.
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Company Inc.
SHARPSBURG • PITTSBURGH 13, PA.
European representative: Brassert & Co., Geneva, Switzerland

a new building to house the turboblowers and auxiliary equipment.

As a part of the recently announced U. S. Steel improvement plan, work has already begun to increase the capacity of the Ohio works 15 open hearth furnaces which are supplied with the iron from the blast furnaces.

C-I DISCLOSES GARY PLANT IMPROVEMENTS

▲ Carnegie-Illinois Steel Corp. disclosed comprehensive improvements in its operations at Gary, Ind. They are: (1) rebuilding of two coke oven batteries at the Gary steel works, and (2) revamping of stainless steel facilities at the Gary sheet and tin mill.

The coke oven batteries to be rebuilt are Nos. 13 and 15. The former battery already is dismantled and undergoing reconstruction. The battery, including 77 coke ovens, is scheduled to be returned to operation in December of this year. Dismantling of No. 15 battery is underway and it is to be rebuilt by May, 1951.

HOMESTEAD RESUMES OPERATION OF OLD MILL

▲ The return to operation of Homestead district works' 32-in. slabbing mill, for a temporary period, was announced by H. G. McIlvried, general superintendent.

The mill, built in 1887, has been used recently only on a standby basis, and its return to operation at this time will be to reduce stocked ingots to slabs which in turn will be used for flat rolled products such as plate, sheet and strip.

Although the mill will be operated only one shift, it will return to work 75 employes who have been on a "laid off" basis. This will permit the production of enough slabs to help maintain maximum production on those mills requiring slabs as raw material.

TRANSFORMER FIRM APPOINTS EXPORT AGENT

▲ Pennsylvania Transformer Co., Canonsburg, Pa., manufacturers of electrical distribution and power transformers, announces the appointment of Philips Export Corp., 100 E. 42nd St., New York, N. Y., as Pennsylvania's export sales representative.

CONTAINER PLANT REARRANGES FACILITIES

▲ Plans for a program of improvements at the Sharon plant of United States Steel Products Co., involving a modern rearrangement of plant facilities, were announced recently.

The project involves the construction of five new buildings and a streamlining of operations at this U. S. Steel plant which manufacturers steel containers for the oil, chemical, food, drug and other industries. The plant delivers to customers in 16 eastern and southern states on most products, and to the entire country on stainless steel containers.

Included in the program are a steel storage warehouse, a new structure to house press equipment, a paint storage building, relocation of the stainless steel production facilities in a fourth new unit, and modern locker and wash rooms, and other comfort facilities for the plant's 400 employes.

Completion is scheduled before the end of the year.

DONORA PLANT TO INSTALL GAS WASHER

▲ American Steel and Wire Co. announced it will install the latest equipment for washing blast furnace gas in its steel works at Donora, Pa.

Harold Cope, general superintendent of Donora works, said the new gas washer will replace the present equipment with the best facilities available for reclaiming fine iron ore dust which is present in the gas taken off from the top of the plant's two blast furnaces. Improved operating conditions will result.

The gas, after it has been cleansed, is reused in the blast furnace smelting process, and the recovered dust is charged back into the furnace.

Installation of the new unit will start soon and it is expected it will be completed sometime early next year.

GREAT LAKES CARBON BUYS ST. LOUIS COKE PLANT

▲ Great Lakes Carbon Corp. has purchased the coke plant of the Laclede Gas Light Co. at St. Louis, Mo.

The plant specializes in top quality metallurgical coke, which it will continue to produce for foundries, blast furnaces, smelters and other industrial users. Customers have been advised that Great Lakes Carbon Corp. will continue to serve them, and they have been asked to continue to direct their inquiries, as heretofore, to the same distributors who have handled the plant's coke sales for many years.

This announcement was the first official confirmation by Great Lakes Carbon Corp. of earlier reports that the company was negotiating for purchase of the plant. The new owner has been active in the coal and coke industry for many years, originally entering the field as the Great Lakes Coal & Coke Co. in 1919. The corporation now operates quarries and plants in 17 states, and maintains a research laboratory at Morton Grove, Ill.

The St. Louis coke plant is on the site of the first white settlement in Missouri at the confluence of the Mississippi and Des Peres Rivers. It is also the site of the Vulcan Ironworks, which produced iron and steel from Missouri iron ore from 1870 to 1885.

The plant has 56 Koppers ovens and 8 Piette ovens, with a production capacity of approximately 250,000 tons of coke annually. It also produces large quantities of coal tar, ammonium sulphate, nitration and industrial benzol, toluol, pure grades of xylol, crude light and heavy solvent, and crude still residue.

B & W ADDS ELECTRIC WELD TUBE PLANT

▲ The addition of a new mill for the production of electric resistance welded tubing at the company's Alliance, Ohio, plant was announced by Babcock & Wilcox Tube Co.

The new mill, the third such unit for the welded tube division at Alliance, will produce tubing with outside diameters ½ in. and up and with wall thicknesses 20 gage and heavier. It will supplement the other two mills and broaden the scope of sizes of ERW tubing that the company can produce.

HEWITT-ROBINS MOVES CLEVELAND OFFICE

▲ The Cleveland, Ohio, office of the Robins Conveyors division, Hewitt-Robins Inc., has moved from 215 Rockefeller Bldg., to 8905 Lake Ave.

USE THE ENGINEERING MART

BETHLEHEM BUILDS 33-TON ABSORBER TOWER

Giant example of a welded product is this 33-ton absorber tower, 97 ft long and 11 ft in diameter, which was made at the Bethlehem, Pa., plant of Bethlehem Steel Co.

Workman with spray gun is painting the big tower, constructed for the company's Sparrows Point, Md., plant, where a large expansion program is under way. The tower will increase the facilities for distribution of coke oven gas. It was made of ⅜ in. steel plates butt welded together.

Alliance CRANES GIVE YOU

DEPENDABILITY... day after day
OPERATING ECONOMY... year after year

● Keep industry on the move! That's Alliance's aim ... and we do just that, too, dependably, economically. Many industries daily report an uninterrupted flow of production. Their cost accounting departments year after year show reliable, ever-efficient lifting power that never tolerates down time. Why is this? Because Alliance cranes are built by experts, designers and engineers who have accumulated materials-handling experience of 50-odd years. . . . So keep 'em on the move with Alliance's dependable lifting power. Let Alliance, *the world's largest builder of the world's largest cranes,* develop time-saving, money-saving equipment perfectly suited to your company's operations. For best service and equipment you can rely on Alliance.

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Cutaway view showing Clipper Seal installed in adjustable cutterhead of Van Norman ram-type milling machine.

Oil seals overheating?

. . . use the seal that's designed to run cool!

SIMPLE IN DESIGN. The Clipper Seal consists of only two parts—a one-piece concentrically moulded body and a specially designed garter spring, factory assembled into a single compact unit. Available in both split and endless types.

The cutaway drawing shown above indicates how Clipper Seals provided the answer to a difficult sealing problem for the Van Norman Company, well-known makers of quality-built milling machines.

These machines have adjustable cutterheads that are totally enclosed to prevent cuttings and other abrasives from damaging moving parts. The cutterheads are operated at shaft speeds as high as 2000 rpm. Yet the oil seal used must function without overheating.

After trying various seals, the Van Norman Company selected Clipper Seals because their simple design minimizes friction and wear, assuring cool, trouble-free operation and an unusually long service life.

In addition, Clipper Seals do a highly efficient job of keeping lubricant in and keeping dirt and abrasives out. Their tough, dense heel has the rigidity necessary for a press fit in the cavity, while the flexible lip, held in light but positive contact with the shaft by a specially designed garter spring, provides perfect sealing at all times.

These precision-moulded oil seals are available in variety of designs and with a choice of heel and lip compositions to adapt them to practically any sealing requirement. They are furnished in sizes to fit shaft diameters from ⅜" up to 66", for temperatures up to 450F and for shaft speeds up to 3500 rpm. For complete information, write for Brochure PK-46A. Address Johns-Manville, Box 290, New York 16, N. Y.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville CLIPPER SEALS

. . . when you use "NATIONAL" Graphite Stool Inserts

● *It is impossible for molten metal to stick to graphite under any conditions.* This means that an ingot cannot possibly stick to a graphite stool insert. If you are bothered with stickers, equip your stools with "National" graphite stool inserts.

Think of the savings!

No lost time in freeing stuck ingots. Keeps maintenance costs down. For complete information on "National" graphite stool inserts, write to National Carbon Division, Union Carbide and Carbon Corporation, Dept. 1S.

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UNION CARBIDE AND CARBON CORPORATION
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District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

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The biggest news since the invention of flashlights—the brand new leakproof "Eveready" No. 1050 flashlight battery—gives more than double the usable brilliant white light for critical uses than any other flashlight battery we have ever made. NO METAL CAN TO LEAK OR CORRODE.

Personnel News...

William "Bill" Herman, superintendent of the Keystone Steel and Wire Co.'s rolling mills, completed 50 years of continuous service on June 12. He is the first man to achieve this goal in the company's 61-year history. Bill went to work at Keystone in June, 1900, as a 16-year-old "spooler boy," winding wire on spools for the fence machine operators. Bill applied himself, rose from "spooler boy" to more responsible jobs. Before the steel plant was built, Bill was foreman of the fence shop. Transferred to the steel mill side of the plant in October, 1917, he worked in the blooming and rod mills until 1920. Then he was appointed assistant superintendent of the rolling mills. In 1923 he was promoted to superintendent of the steel plant, a responsibility held for ten years until named superintendent of the new rolling mills.

When greater rod rolling capacity was needed to maintain balanced operations, Bill conceived a method of improving the mill's rod rolling practice, speeding up not only rod but billet output. To show what they could do with this new equipment, Bill's rod mill crew of 75 men recently rolled a record tonnage of 1029 tons in 24 hours, 351 tons during an 8-hour shift.

At the annual banquet of the company's 25-Year Club on June 18, Bill was honored for his service with a diamond pin for his 50 years at Keystone. This was presented to him by R. E. Sommer, president and general manager.

Harry O. Johnson, a veteran of 39 years service with American Steel & Wire Co., was transferred from his post as general superintendent of Central furnaces and docks and the company's coke works in Cleveland, Ohio, to company headquarters in the Rockefeller Building. He will perform special duties in the office of the vice president-operations.

John E. Allen succeeds Harry O. Johnson as general superintendent of Central furnaces and docks and the coke works of American Steel & Wire Co., Cleveland, Ohio.

D. J. Richards, vice president-sales, E. F. Houghton & Co., Philadelphia, Pa., has been placed in complete charge of all domestic and foreign sales activities since the recent death of **G. W. Pressell,** formerly vice president and director of sales. Mr. Richards will also act as director of advertising and will supervise the activities of the product development and the sales development department. **John F. Maisch** has been appointed controller.

Calvin F. Coombs was named assistant general traffic manager for Jones and Laughlin Steel Corp., Pittsburgh, Pa. Mr. Coombs joined the J&L traffic department in 1937. He had been employed by the Pennsylvania Railroad for the previous 12 years. Mr. Coombs replaces **Norman R. Heck** who died in June.

Walter G. Crumpton, formerly assistant superintendent, electrical and mechanical departments, Tennessee Coal, Iron & Railroad Co., Bessemer, Ala., has joined the sales force of Tornado Supply Co., Anniston, Ala.

W. C. Snyder, Jr., vice president and manager of the metallurgical department of the engineering and construction division of Koppers Co., Inc., has been named president of Freyn Engineering Co., a wholly-owned Koppers subsidiary with offices in Chicago, Ill. Mr. Snyder's appointment follows the death of **Louis T. Shorley,** former president and treasurer of Freyn, on July 20, 1950. Appointment of **Gordon Fox,** vice president of Freyn, to the post of executive vice president also was announced. In addition, Mr. Fox will fill the unexpired term of Mr. Shorley on the Freyn board of directors. **E. J. Westcott,** secretary of the Chicago engineering firm, will occupy the dual position of secretary and treasurer. Mr. Snyder will retain his responsibilities as manager of the metallurgical department of the Koppers division and his headquarters in Koppers central offices in Pittsburgh. Mr. Fox will manage the activities of Freyn's Chicago headquarters.

George I. Bottcher was appointed chief engineer of Allegheny Ludlum Steel Corp., Brackenridge, Pa. **J. F. Chapman** and **R. E. Smith** were also announced as assistants to the chief engineer.

Mr. Bottcher joined the engineering department of Allegheny Ludlum in 1941, was made construction engineer in 1946 when the company embarked upon a $30,000,000 plant improvement and expansion program and was appointed assistant chief engineer in 1947. Mr. Chapman joined the engineering department

ILLIAM "BILL" HERMAN JOHN E. ALLEN D. J. RICHARDS W. CORDES SNYDER, JR.

UNMATCHED SPEED AND SAFETY

Bonnot Billeteers cut out deep flaws or shallow imperfections with perfect ease, speed and safety. An operator removes a 12" chip in 2 seconds, as the 45 ton machine responds to his finger-tip control, while it takes a hand chipper 30 times longer to do the same job — and hand chipping is grueling work all the way.

What's more, the Billeteer's unmatched speed does this work for 50-60% less than hand chipping costs. At the same time the Billeteer also eases your personnel problem because men like to operate the safe, simple Bonnot Billeteer. Such operators usually "stay put."

In addition, Billeteer-cleaning is definitely preferred over torch-cleaning in many situations, when measured by costs or quality or both.

Many leading steel producers here and abroad have made the profit-wise decision, and employ Bonnot Billeteers for faster—safer—cheaper—better cleaning.

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of Mesta Machine Co. in 1935 and took a similar position with Allegheny Ludlum in 1946. In his new job, Mr. Chapman will be in charge of design and construction engineering for the company. Mr. Smith became associated in 1921 with Allegheny Ludlum as a draftsman at the company's Brackenridge, Pa., plant.

He was made chief draftsman in 1938 and, in 1946, was appointed office manager of the general engineering department. In his new post, Mr. Smith will retain his duties of office manager and will supervise the procurement and expediting of materials as well as serve as supervisor of plant maintenance problems.

All three new appointees will be headquartered in the company's general offices at Brackenridge.

J. Warren Shaver and **William Whigham, Jr.**, have been appointed assistant vice presidents, industrial relations of Carnegie-Illinois Steel Corp. Mr. Shaver

J. WARREN SHAVER

WILLIAM WHIGHAM, JR.

has been an attorney specializing in industrial relations matters for the company. Mr. Whigham was employed in 1919 at the Clairton coke works of Carnegie Steel Co., in the operating department. He left the company in 1930 to become associated with the Dravo Contracting Co., returning to Clairton works in 1933 as superintendent of maintenance. In 1938 he was transferred to the staff of the vice president, finance and since 1941 has been on the staff of the vice president, industrial relations of Carnegie-Illinois coordinating

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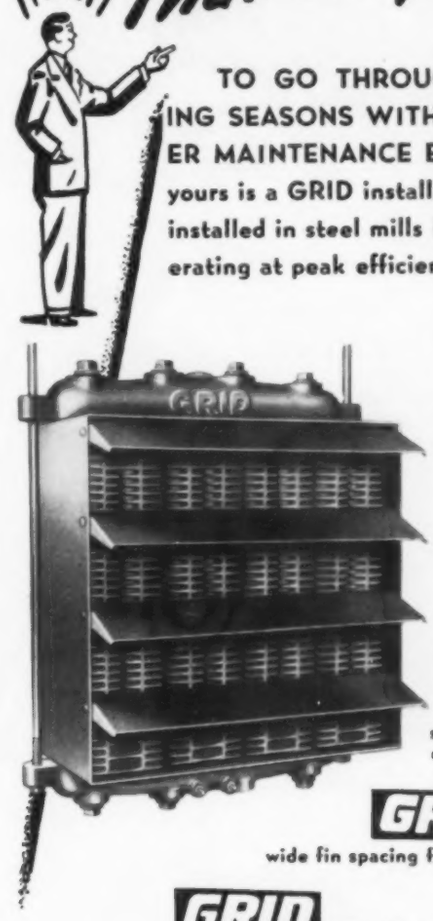

TO GO THROUGH MANY HEATING SEASONS WITHOUT UNIT HEATER MAINTENANCE EXPENSE, providing yours is a GRID installation? GRID Units installed in steel mills in 1933 are still operating at peak efficiency. The steel mill operators do not recall having spent maintenance time on them. This performance is possible because:

GRID cast iron construction withstands corrosive fumes.

GRID wide fin spacing facilitates easy cleaning.

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GRID fins are cast integral with the steam chamber assuring even distribution of heat. It's not possible for GRID fins to come loose from the steam chamber to cause loss of heating efficiency.

GRID design incorporating proper fan sizes, motor speeds and outlet temperatures results in a properly balanced heating unit, especially when high steam pressures are used.

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Kettle Life More Than Tripled with F. E. I. *Patented Settings*

Out of Furnace Engineers' more than 30 years experience has come the ALL-IN-ONE BUY for galvanizing that sets new records for high production at low cost.

UNIQUE DESIGN ... NO STACK REQUIRED. In a typical Pipe Galvanizing plant, kettle life was increased from 20,000 to 70,000 tons, thanks to F.E.I. patented baffle type burners and eductor, requiring no costly stack.

AUTOMATIC CONTROL ... FLEXIBILITY. F.E.I. *fully automatic control* insures uniform temperature, flexible high and idling operation, minimum fuel consumption, increased output. Loss from shut-downs, formerly a major item, is now negligible. F. E. I. service is complete—from original analysis of your needs through to actual production.

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Top photo: **F. E. I. equipment for galvanizing sheets.**

Lower photo: **F. E. I. installation for galvanizing metalware.**

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matters pertaining to personnel, training, education, and wage and salary administration. In his new capacity Mr. Whigham will continue to devote much of his attention to the development and installation of comprehensive programs of management alinement and related matters.

William A. Holt is now associated with Salem Engineering (Canada) Ltd., Toronto, Ontario. Mr. Holt was with Atlas Steels Ltd., Welland, Ontario for 15½ years, the latter 8 years as assistant superintendent of maintenance and service. In 1949 he joined Addisson Industries, Ltd., Toronto, Ontario and has left them to accept the present position.

J. R. Ferguson, formerly assistant to general superintendent, South works, Carnegie-Illinois Steel Corp., Chicago, Ill., is now connected with Orinoco Mining Co., 25 Broad St., New York 4, N. Y.

E. I. Williams, formerly engineer with J. M. Foster Co., Gary, Ind., is now business manager, McGraw Construction Co., Middletown, Ohio.

M. Worth Acker was named chief engineer of Midvale Co., Philadelphia, Pa. Mr. Acker who is a graduate of the University of Pennsylvania entered the employ of the company in 1936. Formerly chief metallurgical engineer, he is now in charge of all engineering. **Edward L. Murphy,** formerly assistant engineer of tests, has been appointed engineer of tests. Mr. Murphy was first employed at Midvale in 1938. He is a graduate of Villanova College.

E. W. Blind, superintendent, **John Adolphson,** assistant superintendent, and **Joseph Kohlberg,** chief chemist, have joined Great Lakes Carbon Corp., and will continue in their present capacities at the St. Louis, Mo., coke plant which the corporation has just taken over from the Laclede Gas Light Co.

George H. McBride has been appointed manager of the gearing division of Westinghouse Electric Corp., Pittsburgh, Pa. Mr. McBride, who has been manager of sales for the gearing division since 1942, succeeds **L. R. Botsai.** Mr. Botsai now is manager of the Westinghouse plant in Buffalo, N. Y.

E. R. Shepard has joined the Hinchman Corp., Detroit, Mich., as technical associate. Mr. Shepard has had wide and varied experience with the Corps of Engineers and the National Bureau of Standards in the fields of soil corrosion, cathodic protection and geophysics. After graduating in electrical engineering from the University of California, Mr. Shepard spent two years at Harvard in the study of physics, leading to the degree of master of arts. Following four years of teaching physics and electrical engineering at Oregon State College, Mr. Shepard entered the employ of the National Bureau of Standards, where he devoted eleven years to mitigation of stray current electrolysis and the study of soil corrosion. Since 1933, while in the employ of the Public Roads Administration and the Corps of Engineers, Mr. Shepard has devoted a large portion of his time to the design and operation of seismic and electrical resistivity instruments used for subsurface explorations.

Richard A. Weppner has been appointed sales engineer for Atlas Mineral Products Co., Mertztown, Pa., for corrosion-resistant chemical construction materials in Delaware, Maryland, Virginia and parts of West Vir-

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for Steel Mills and Industrial Furnaces

- Long Flame Gas Burners
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- Differential Pressure Constant-Flow Oil Valves
- Steam-Oil Pressure Ratio Regulator
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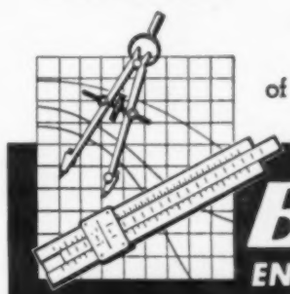

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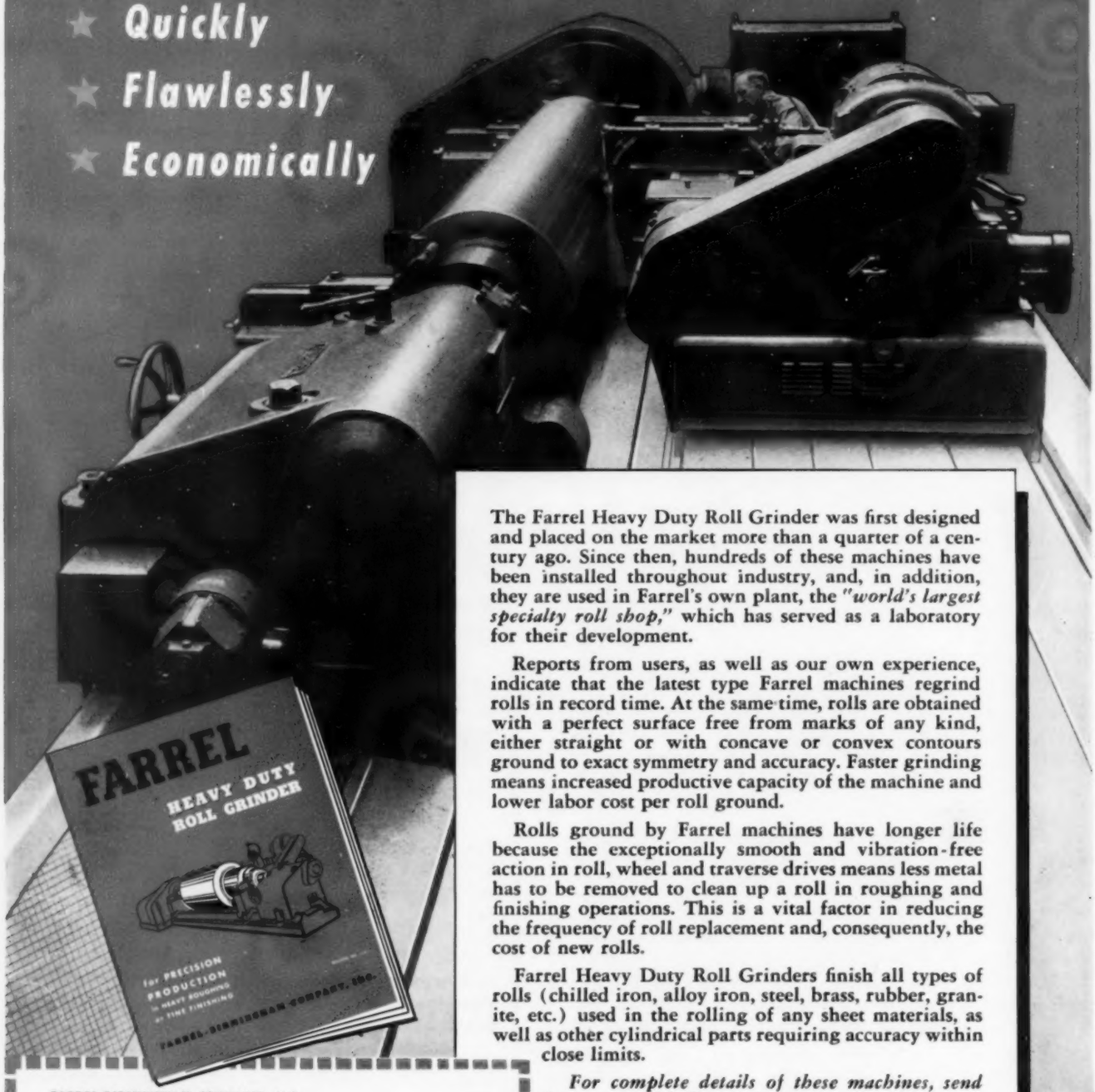

The Farrel Heavy Duty Roll Grinder was first designed and placed on the market more than a quarter of a century ago. Since then, hundreds of these machines have been installed throughout industry, and, in addition, they are used in Farrel's own plant, the *"world's largest specialty roll shop,"* which has served as a laboratory for their development.

Reports from users, as well as our own experience, indicate that the latest type Farrel machines regrind rolls in record time. At the same time, rolls are obtained with a perfect surface free from marks of any kind, either straight or with concave or convex contours ground to exact symmetry and accuracy. Faster grinding means increased productive capacity of the machine and lower labor cost per roll ground.

Rolls ground by Farrel machines have longer life because the exceptionally smooth and vibration-free action in roll, wheel and traverse drives means less metal has to be removed to clean up a roll in roughing and finishing operations. This is a vital factor in reducing the frequency of roll replacement and, consequently, the cost of new rolls.

Farrel Heavy Duty Roll Grinders finish all types of rolls (chilled iron, alloy iron, steel, brass, rubber, granite, etc.) used in the rolling of any sheet materials, as well as other cylindrical parts requiring accuracy within close limits.

For complete details of these machines, send for a copy of bulletin 115. No cost, no obligation.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONN.
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Sales Offices: Ansonia, Buffalo, New York, Pittsburgh, Akron, Chicago, Los Angeles, Houston

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Farrel-Birmingham

FB-574

ginia and New Jersey. **Philip E. Berens** has been appointed sales representative for corrosion-resistant materials in eastern Pennsylvania, western New York and parts of New Jersey. **William A. Streaker** has been appointed sales engineer for corrosion-proof materials in the lower peninsula of Michigan, eastern Indiana and Lucas County in Ohio.

H. Lee Reynolds, who in 1917 introduced and promoted the sale of asbestos insulated wires and cables in the Pittsburgh, Pa., area, on July 1 discontinued the sale of such products. They will now be sold by construction materials department of the General Electric Co. Mr. Reynolds is a manufacturer's agent and will continue to represent the Union Metal Manufacturing Co.

John J. Miller has been appointed manager of the industrial division, St. Louis office, of General Electric Co.'s apparatus department mid-states district. In his new capacity, Mr. Miller will be responsible for all sales to industrial companies in the St. Louis area of the department's newly-created twelfth sales district.

George D. Smittle has been appointed district manager of the Ohio Valley district for Brooks Oil Co., Pittsburgh, Pa. Before joining Brooks, Mr. Smittle had

GEORGE D. SMITTLE

for many years been superintendent of maintenance for Follansbee Steel Corp., Toronto, Ohio. As Ohio Valley district manager, his headquarters will be at Steubenville, Ohio.

H. R. Gibbons was appointed chief engineer of Hyatt Bearings division of General Motors Corp., Harrison, N. J. Mr. Gibbons has been assistant chief engineer for the past seven years. He originally joined Hyatt in 1914, after graduating from Stevens Institute of Technology with a M.E. degree. His early experience was in the accounting and manufacturing divisions, followed by 3½ years in the Detroit office on automotive engineering work. On his return to Harrison, he was placed in charge of product research and design and played an important part in the development of many new lines of the Hyatt Bearings. **O. W. Young**, who has been associated with Hyatt since 1915 and served as chief engineer from 1928, was named technical assistant to the general manager.

James W. Bennett was appointed general sales manager for Penn Industrial Instrument Co., Philadelphia, Pa. Mr. Bennett has devoted his entire business career

Dravo Crane Cab Coolers are simple to install; all parts are readily accessible for servicing.

DRAVO CRANE CAB COOLERS
ASSURE OPERATOR COMFORT

Operators of hot-metal cranes are more alert and efficient when you protect them from fatigue and discomfort by air conditioning the cabs with Dravo Crane Cab Coolers.

Completely self-contained, and requiring only an electrical connection, the Dravo Crane Cab Cooler provides complete air conditioning:

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WARE HI-LAG Fuses have the strongest, most rigid knife-blade assembly ever designed in fuses. The two heavy fibre bridges are supported by sturdy brass brackets which add greatly to the strength of the assembly. These bridge supporting brackets are attached to the copper knife-blades and contact the entire end of links, so that current flows through the brackets as well as the blades over a large area. Another reason for WARE HI-LAG Fuse's cool operation.

In addition to WARE Hi-Lag Renewable Fuses, we make:
WB Renewable Fuses without special time lag;
WARE Non-Renewable Fuses, rugged one time construction;
WARE Trolley Tap Fuses designed specially for coal mines.

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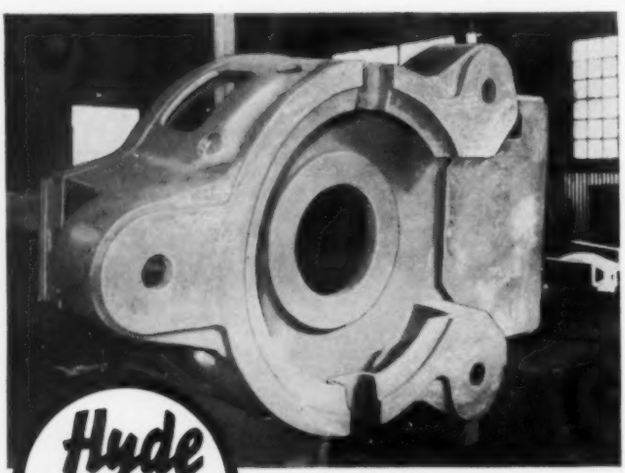

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Up to 80,000 Pounds

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ROLLING MILL MACHINERY

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HYDE PARK, PA. (PITTSBURGH DISTRICT)

to process and power plant instrumentation since he was graduated in 1939 from the University of Cincinnati with a degree in mechanical engineering. For the past five years he has done special engineering sales work for Energy Control Co.

Obituaries

Gustav H. Zimmer, 68, died June 29. A native of Posen, Germany, Mr. Zimmer was educated at Elfeld, Beria, and graduated from the University of Darmstadt in 1904. Coming to Buffalo in 1908, he took a position with Buffalo Forge Co. in the engineering department. Shortly after this he became chief engineer of the machine tool division of this company, which position he held until illness forced his retirement several months ago.

Millard H. Ronzone, 54, treasurer of Copperweld Steel Co., Warren, Ohio, was killed July 13 in an airplane crash near Pittsburgh, Pa.

Louis T. Shorley, 60, president and treasurer of Freyn Engineering Co., a wholly-owned subsidiary of Koppers Co., Inc., with headquarters in Chicago, Ill., died July 20. Mr. Shorley had been president of Freyn Engineering since 1946. From 1907 to 1917 he was in charge of cost accounting for the Carnegie-Illinois Steel Corp., and in 1917 he graduated from the Northwestern School of Commerce. Since 1917 he had served as auditor, secretary, and later as vice president and treasurer of Freyn.

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FEWER SHUTDOWNS, CONSEQUENTLY GREATER PRODUCTION . . . IF YOU SPECIFY AND ORDER:

- **FALCON COOLING PLATES**, both Bosh and Inwall—because they are made without those leak producing anchors and chaplets.
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- **FALCON BAFFLE ARRANGEMENTS** provide maximum circulation of cooling water and the elimination of sediment deposits.
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Solves Control Problems!

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Soaking Pit . . . Since the first Askania Control was installed for a soaking pit at one of the large steel mills, *all pits* have been equipped with duplicates of the original control. Operation proved that Askania's accuracy over wide turndown range, safety, simplicity and ease of maintenance solved the control problem! Only Askania offered the ideal combination of all these features.

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Gas Mixing . . . An Askania Control System for gas mixing was installed in a large midwestern utility company in 1937. Proving that Askania offered the best answer to this control problem, the company has since *standardized* on Askania Gas Mixing Controls.

Efficient, automatic, trouble-free operation of Askania Controls gives this utility company the results it requires.

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The optimum combination of accuracy, dependability, low maintenance and ability to work with small pressures solved this company's control problem.

Find out how Askania offers the right combination of accuracy, dependability, simplicity, stability and safety . . . Find out how Askania can offer the best solution to your control problem . . . Send for Bulletin 139.

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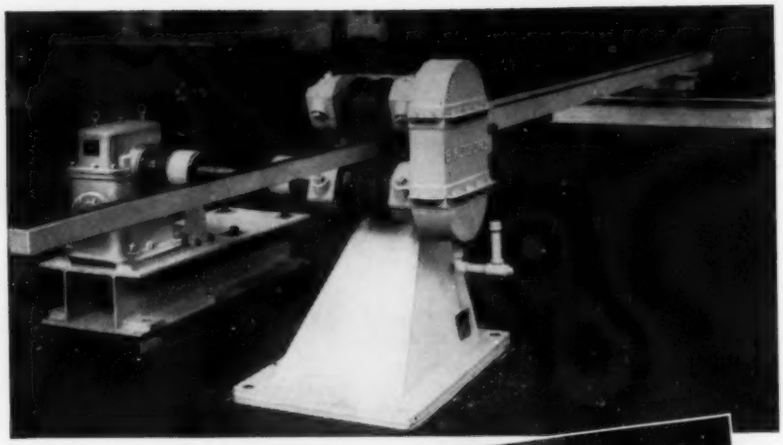

Whether you are adding a single piece of machinery or planning a complete new plant, Birdsboro engineers will give you any help you need or start from scratch to help you solve any steel mill equipment problems.

Top—Furnace Billet Ejector

Right—14" Bar Mill Cross Country Tables & Transfers

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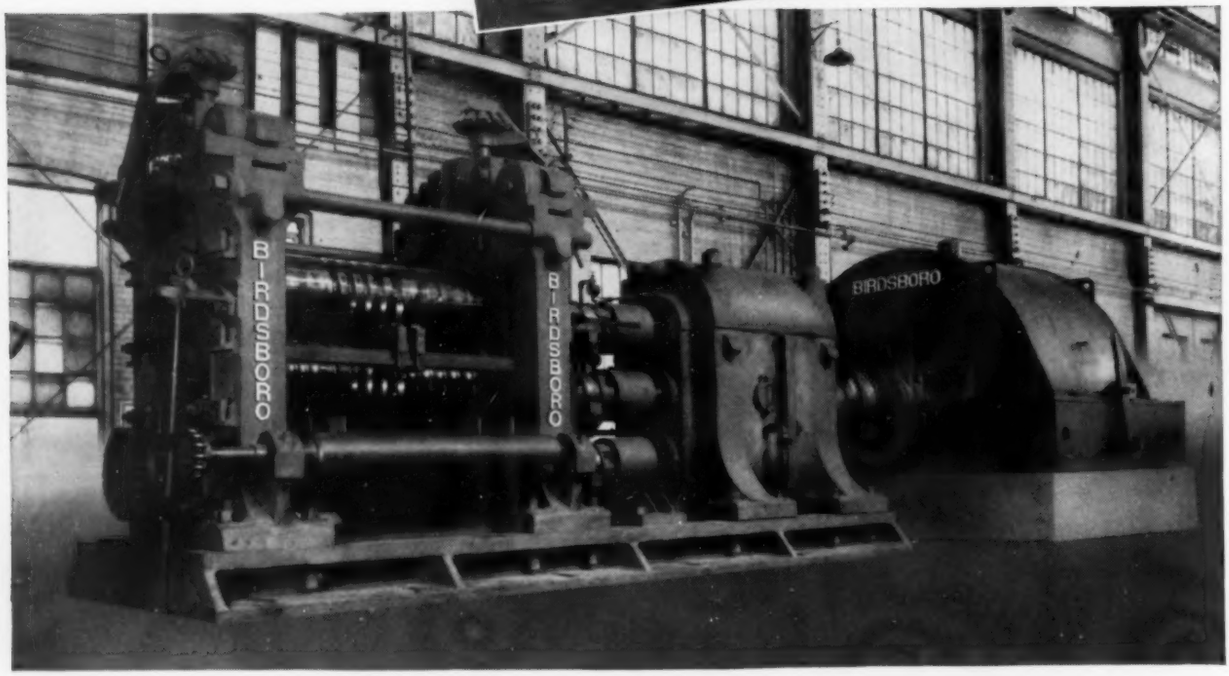

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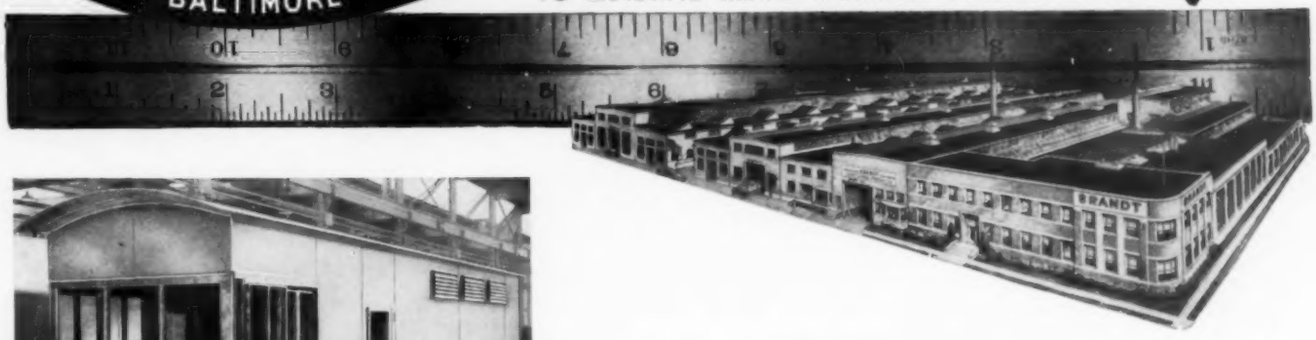

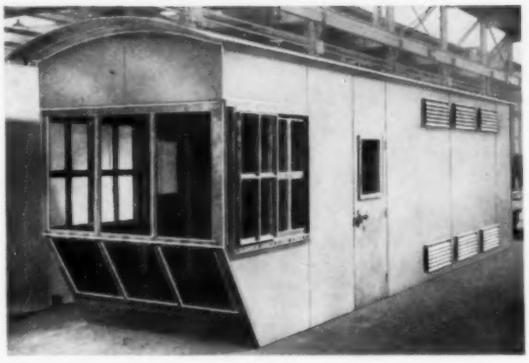

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30 TON ELECTROLYTIC PLATING TANK BUILT FOR A STEEL MILL CUSTOMER

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Brandt's 240,000 sq. ft. of efficient metal working facilities are a *real help* in solving your engineering and production problems. A bid from Brandt is the *right start* to *save time* and *money* too. Completely equipped for fabricating *any type* of metal. Since 1890, experienced in handling a variety of specialized products in a wide range of sizes. Typical steel mill jobs (illustrated) also include pickling tanks — plain or rubber lined, completely assembled.

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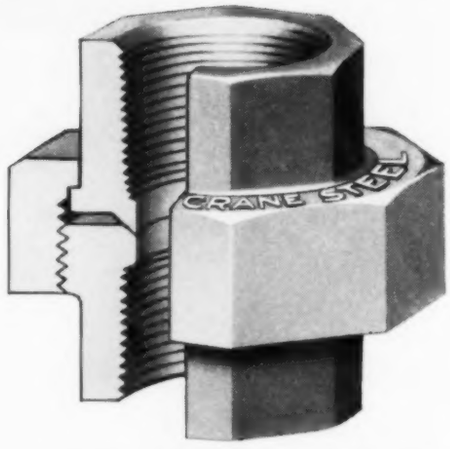
EXTRA BODY STRENGTH ... EXTRA HOLDING POWER IN COMPACT DESIGN

Crane Forged Steel Ground Joint Unions are exceptionally strong, tough and durable. Ample reinforcement at points subject to greatest stress makes them particularly suitable for high pressures and temperatures—and other severe services on steam, oil, water, air, or gas lines.

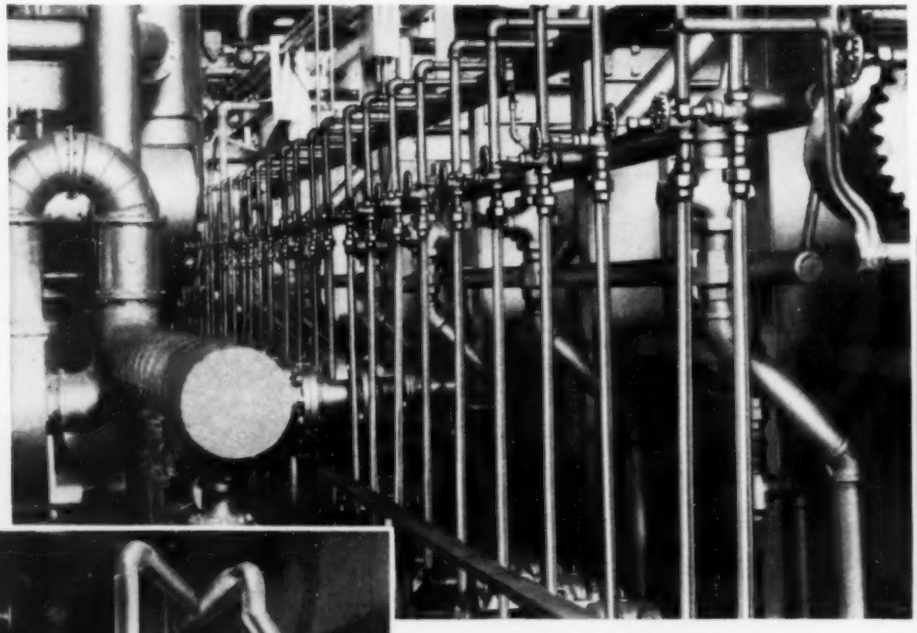
Crane precision-machined union seats—steel to steel or steel to brass—hold pressure easily. No gasket is required. Furnished all cadmium plated or with cadmium plated union ring only. This feature provides resistance to rust, and acts as a permanent and effective lubricant. Extreme accuracy of Crane machining permits interchangeability of all parts. For a complete selection of dependable unions, see your No. 49 Crane Catalog, p. 183.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas



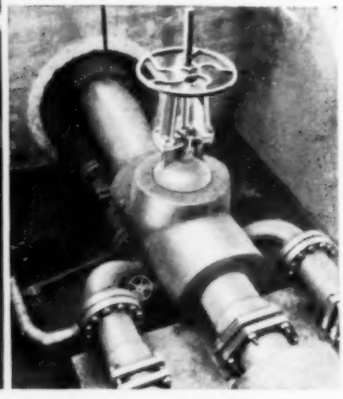
WORKING PRESSURES: 2000 pounds water, oil, or gas. Steel to Steel Seat—585 pounds steam or hot oil, 900° F. Brass to Steel Seat—600 pounds steam or hot oil, 550° F. Sizes: ⅛ to 3 in.

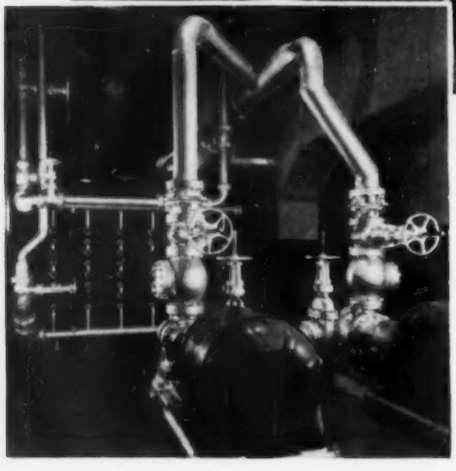
● FOR THE WORLD'S MOST COMPLETE SELECTION OF QUALITY PIPING MATERIALS ... LOOK ALWAYS TO CRANE



DISC TYPE NORMALIZER *featuring Crane brass gate valves, unions, flanged fittings, and pipe.*

STEAM DISTRIBUTION LINES *in a large steel plant. Crane equipment includes steel valves, pipe and flanged fittings.*





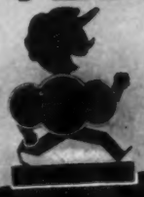
OIL CIRCULATING PUMPS *equipped with gate, globe, check and relief valves from the complete Crane line.*

EVERYTHING FOR EVERY PIPING SYSTEM

CRANE

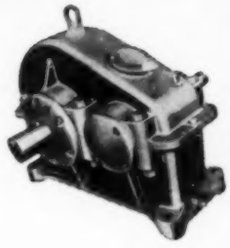
VALVES • FITTINGS • PIPE • PLUMBING AND HEATING

There's a De Laval Reducer for EVERY SERVICE

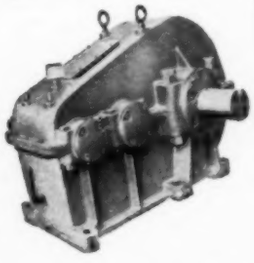


IMO-De Laval Herringbone Gear Reducers

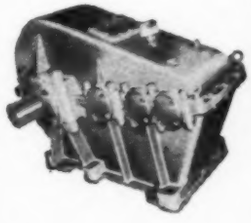
IMO-De Laval Herringbone Gear Speed Reducers are made in single, double and triple reduction units for ratios up to 300 to 1 and for transmitting up to 1000 hp.



Single reduction

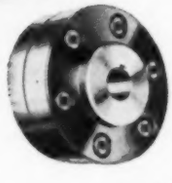


Double reduction



Triple reduction

IMO-De Laval Gear and Crown Couplings

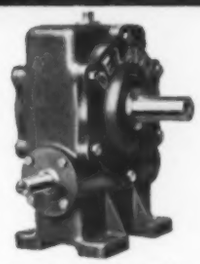


IMO-De Laval Crown coupling.

IMO-De Laval Gear coupling.

IMO-De Laval Worm Gear Reducers

IMO-De Laval Worm Gear Speed Reducers are made in single and double reduction units with ratios up to 8000 to 1 and for transmitting up to 250 hp.



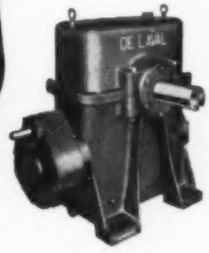
Horizontal, single reduction bottom or top drive in 3" and 3½" center distances.

Horizontal, single reduction bottom or top drive for torque service and moderate overhung loads.

Horizontal, single reduction bottom or top drive, torque or heavy overhung load service.

Vertical shaft, single reduction.

Double reduction worm gear with horizontal shaft.



Double reduction worm and helical with horizontal shaft.

Double reduction worm and helical with vertical shaft.

DE LAVAL

IMO-DE LAVAL PRODUCTS DIVISION

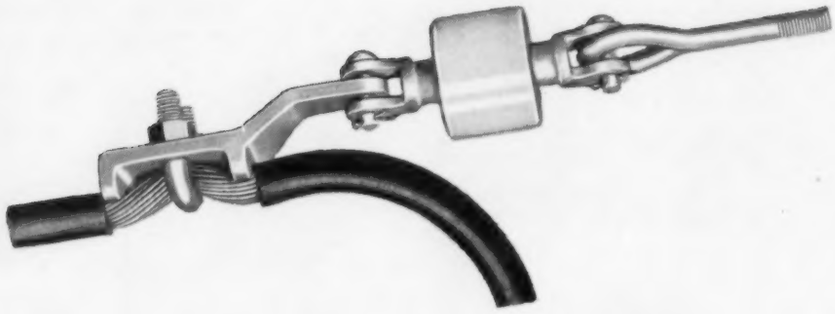
Send for Catalog GWB-26-R.

DE LAVAL STEAM TURBINE CO.

TRENTON 2, N. J.

WG-26

"DEAD-END" YOUR FEEDER CABLE SIMPLY . . . SAFELY . . . SECURELY!



Positive insulation — superior strength . . .

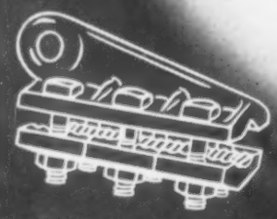
For over thirty years, industry has been choosing Keystone clamps and insulators to dead-end heavy feeder cables.

Cables just don't pull free from Keystone clamps—abundant bearing surface and sturdy construction insure a permanent installation. Sound design makes these clamps easy to attach, easy to tighten, easy to tape.

You'll find that Keystone Giant Strain Insulators will prevent current leakage, short circuiting and flash-over, even under adverse operating conditions. They're available in mica or porcelain, in all sizes and with a variety of fittings.

If you want positive clamping, high tensile strength and dependable insulation, you want Keystone cable clamps and insulators. For more detailed information, send for our new booklet on Industrial Feeder and Traveling Electrical Contact Material.

Typical application of Type "P" clamp, using No. 61349 Porcelain Covered Strain Insulator.



TYPE S-6 KEYSTONE Cable Strain Clamp. Similar to S-4, above, but with 6 bolts and separate clamping portions for heavy duty.

TYPE PD KEYSTONE Cable Strain Clamp. Two forged U-bolts provide increased cable grip where high strain is encountered. Bronze U-bolts for AC service.

TYPE S-4 KEYSTONE Cable Strain Clamp. Internally corrugated to assure firm grip on cable. Bronze lower half furnished for AC service.

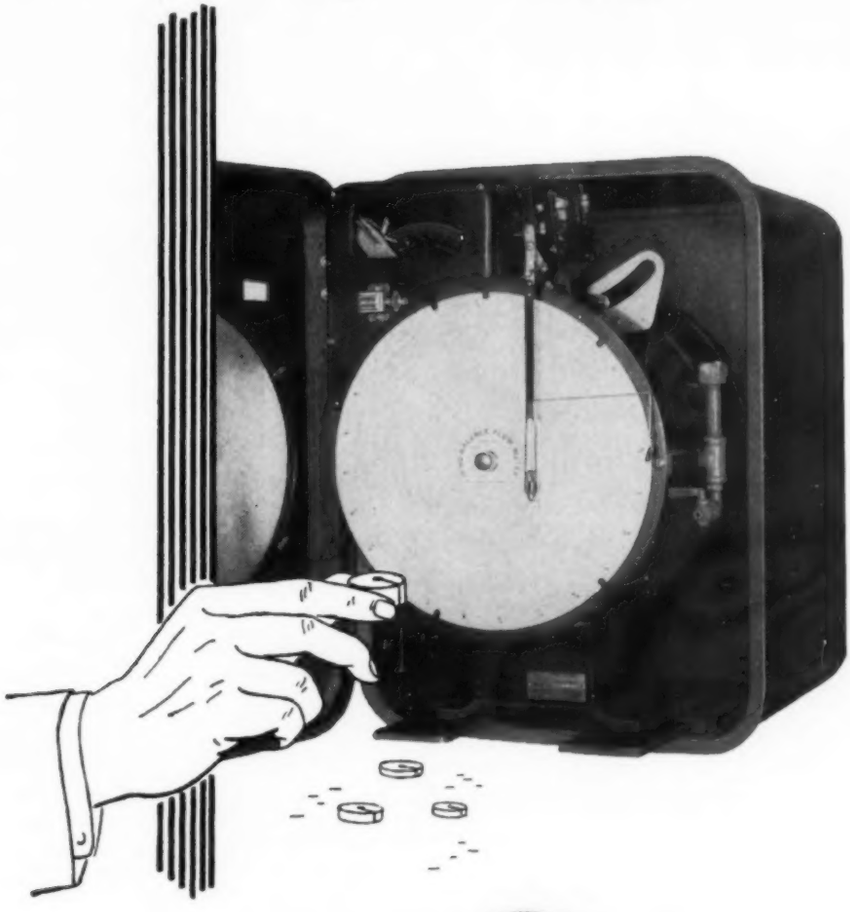
TYPE HW KEYSTONE Cable Strain Clamp with Insulator. Insulation is cut away from cable at clamping point. Keeps strain in direct line with center of cable.

ELECTRIC SERVICE MANUFACTURING CO.

1721 CAMBRIA STREET • PHILADELPHIA 32, PENNA.

MAKERS OF CONTACT RAIL AND WIRE SUPPORTS, AND COLLECTION DEVICES

Quick, accurate dead-weight calibration under full operating pressure



with HAGAN RING BALANCE METERS

You *can* calibrate or check Hagan Ring Balance Meters by the traditional water column method if you wish—but it isn't necessary.

It is far quicker and easier to use the set of standardizing weights furnished with each meter—and the results are the same.

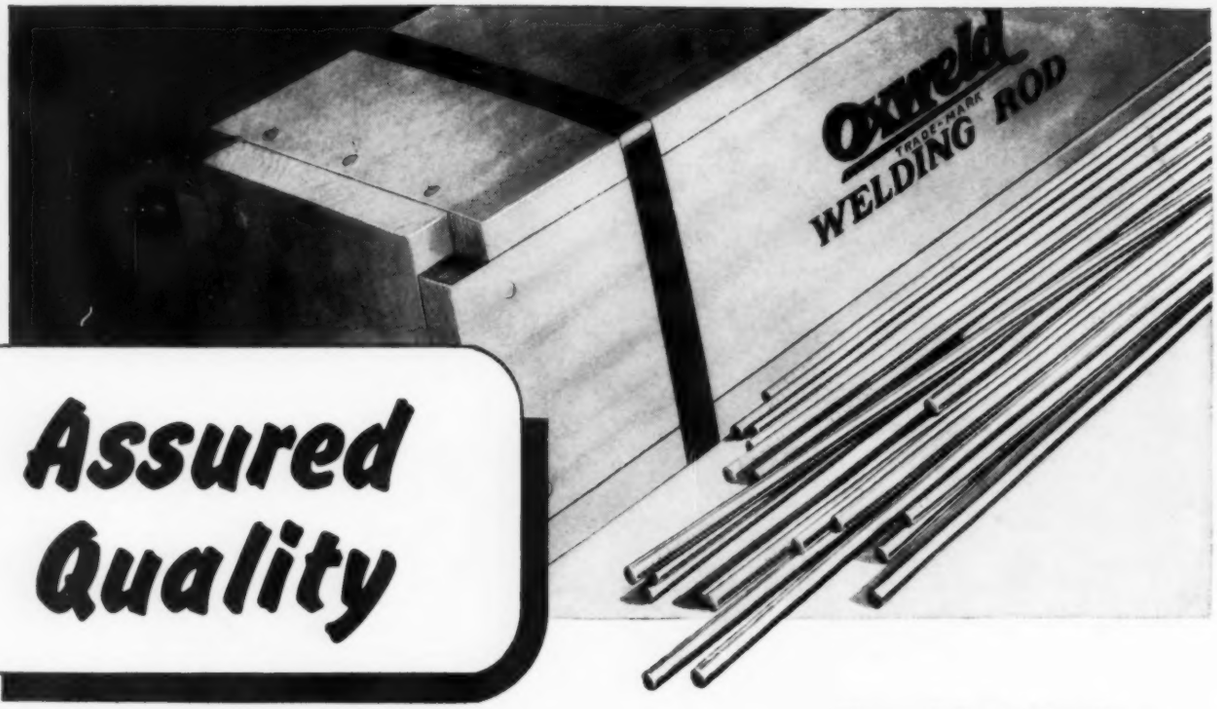
Simply equalize the meter, hang the check weights on the sheave cable, (see illustration) and compare the resultant pen readings with the corresponding calibration values. Each check weight is stamped with a value for calibration purposes.

For full information on this and other features of Hagan Ring Balance Flow Meters write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pennsylvania.

HAGAN HALL BUROMIN CALGON

HAGAN CORPORATION

RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS



Assured Quality

The quality of any weld—its strength, ductility, grain structure, machinability, surface finish—depends largely on the rod used to make it. Only the best rods consistently give good welds of uniformly high quality. Only the best can help you to weld better and faster at lower cost . . . and help to make your job easier, too.

There are two good reasons why OXWELD Welding Rods are the best that modern science knows how to make. First, their rigid specifications are carefully worked out in LINDE research laboratories, which are among the largest and best equipped in the world. Second, LINDE engineers at production points constantly check during manufacture to see that the rods conform to these specifications.

They inspect ingots and billets, sample heats for chemical analysis, make flame and weldability tests, weld and test coupons for strength and ductility. In short, every known precaution is taken to maintain a uniformly high standard.

Every OXWELD Welding Rod that goes to market is of proved physical and chemical analysis . . . free from all objectionable properties and impurities. The OXWELD trade-mark is your guarantee of quality and satisfaction.

The terms "Oxweld," "Prest-O-Weld," and "Purox" are registered trade-marks of Union Carbide and Carbon Corporation.

These 5 Rods Handle a Complete Range of Welding

OXWELD No. 1 H. T. Steel

For all high-strength steel welding. Develops tensile strengths 11,000 lb. per sq. in. higher than ordinary steel.

OXWELD No. 7 Drawn Iron

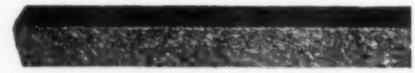
A remarkably ductile, copper-coated rod for all run-of-shop steel welding on materials up to ¼-inch thick.

OXWELD No. 25M Bronze

A superior rod for all braze-welding, building up wearing surfaces, and fusion welding of copper alloys.

OXWELD No. 23 Aluminum

For all-purpose welding of aluminum and its alloys. Prevents weld cracking by absorbing cooling stresses.



OXWELD No. 9 Cast Iron

An ideal rod for fusion welding gray iron castings. Weld metal is fine-grained, soft, and easily machined.

9 additional welding rods and 8 hard-facing rods for more specialized work.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

30 East 42nd Street UCC New York 17, N. Y.

Offices in Other Principal Cities

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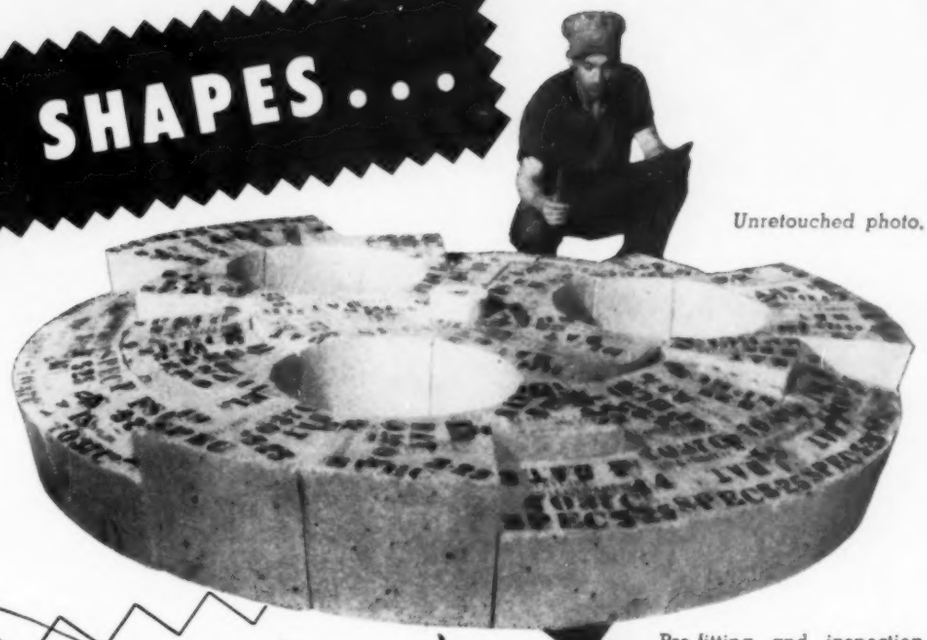
SPECIAL SHAPES . . .



Unretouched photo.

Pre-fitting and inspection of a Taylor Sillimanite (TASIL) Electric Furnace Roof prior to shipment from the Chas. Taylor plant.

Custom Taylored

HERE'S THE PATTERN OF *Taylor service*

1. Determine the right composition and structure to meet your service requirements.
2. Select the most efficient and economical method of forming.
3. Produce under strict control.
4. Fire in modern periodic or tunnel kilns.
5. Finish, assemble and mark to identify.

HERE'S THE RESULT *for you!*

1. A shape or complete assembly engineered for *your* job.
2. *Time saved*—pre-fitting means quick, accurate installation with minimum cutting and fitting on the job.
3. *Money saved*—through lower masonry cost; longer refractory life; uninterrupted production.

The CHAS. TAYLOR SONS Co.

MANUFACTURERS OF REFRACTORIES • CINCINNATI • OHIO • U.S.A.

For 86 years we've been making shapes for every metallurgical need—large and small, simple and complex. Entrust your next special shape order for Taylor Sillimanite (mullite), TACOR (corundum) and Taylor Zircon to Chas. Taylor. You'll know it will be made to your specifications and satisfaction. See your *Taylor* representative.

Exclusive Agents in Canada:
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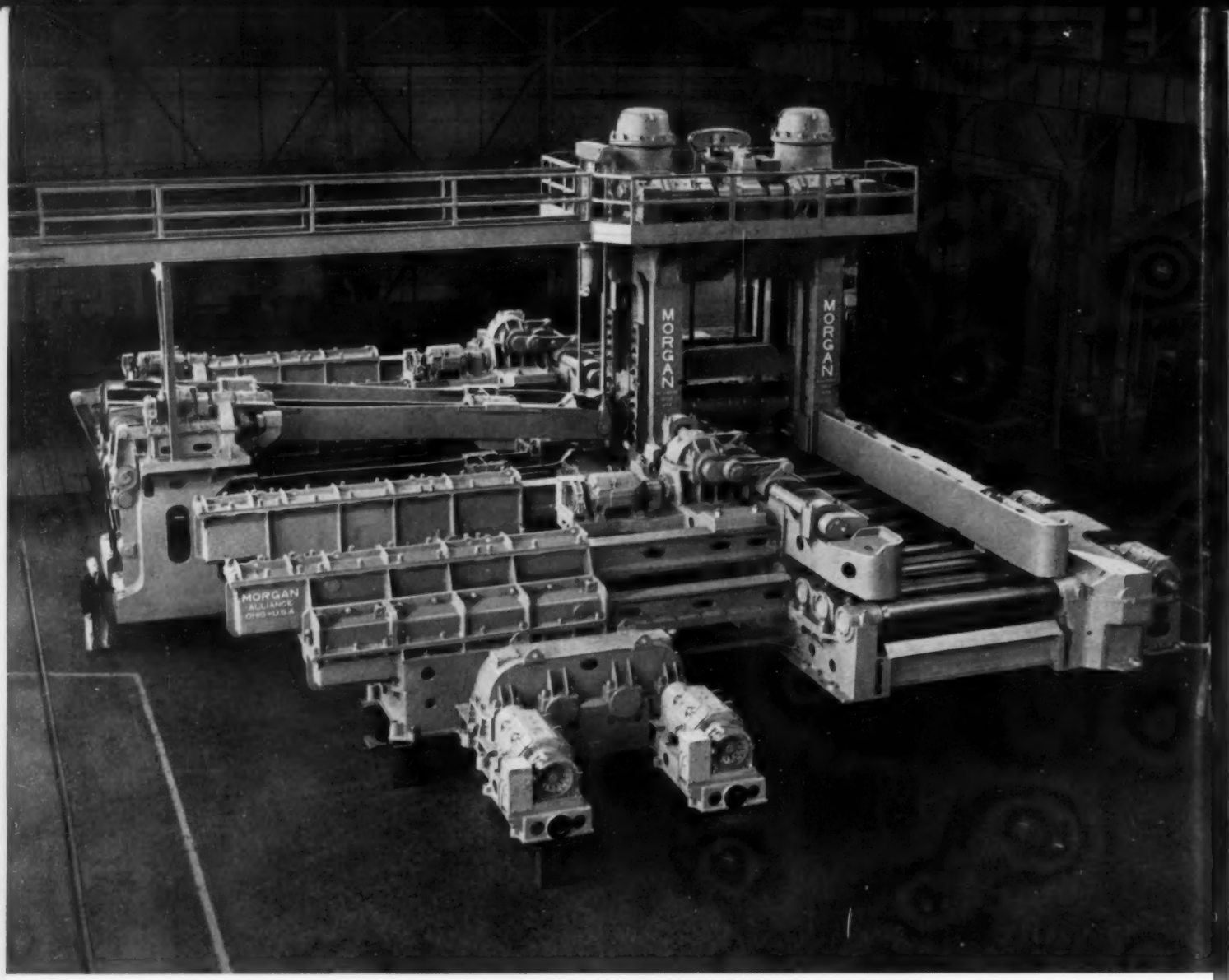

44" TWIN MOTOR DRIVE BLOOMING MILL

Morgan 44"—2 High Reversing Blooming Mill to be direct connected to two 4000-Hp., 50/120 Rpm. Motors. Top roll and both spindles are hydraulically balanced by individual cylinders connected to an air hydraulic system. Speeds of motor driven screw down, feed rollers, mill tables and manipulator are regulated by variable voltage control.

Mill tables have box type cast steel girders. Rollers are forged steel equipped with anti-friction type bearing cartridges. All gears have hardened teeth, are totally enclosed and operate in oil. Manipulator is of the electric overhead type with retractable heads affording maximum accessibility to all parts of the mill tables.

We design and build mills and mill machinery for the steel industry. For your next mill and equipment, consult—

MORGAN *Engineering*

THE MORGAN ENGINEERING CO.

ALLIANCE, OHIO PITTSBURGH—1420 OLIVER BUILDING

DESIGNERS • MANUFACTURERS • CONTRACTORS • BLOOMING MILLS • PLATE M
STRUCTURAL MILLS • ELECTRIC TRAVELING CRANES • CHARGING MACHINES • INGOT STRIP
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HAMMERS • STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL M

Equipment News...

NEW MOTOR LINE ANNOUNCED BY WAGNER ELECTRIC CORPORATION

▲ Wagner Electric Corp. recently announced the development of a full line of cast iron frame totally enclosed fan-cooled motors which are available in ratings from 5 hp through 250 hp in both standard and explosion-proof designs.

These cast iron frame motors are especially suitable for applications in chemical plants, oil fields, petroleum refineries and similar industrial plants where corrosion is a problem, either because of the nature of the materials processed or because the motors must be installed outdoors.

Construction details include:

1. *Cast iron frame*—A rugged, corrosion resistant unit whose inner frame, outer frame and feet are cast in one piece.
2. *Cast iron endplates.* — Liberally designed, and ribbed to add extra mechanical strength. Heavy cap screws secure them in the correct position, as determined by precision machining of both frame and endplates.
3. *Cast iron blower shield*—A one piece, easily removable blower shield with integrally formed air intake protects the external blower. A cast iron shield on the drive end is designed to deflect the emerging air stream around the bearing.
4. *Corrosion resistant blower*—The blowers used on type EP motors are of malleable iron, those used on type JP motors are of non-sparking bronze. On all except the largest ratings, the blower design permits operation of the motors in either direction of rotation.
5. *Cast iron conduit box*—The two piece, diagonally split conduit box is screwed onto a threaded nipple which is brazed to the stator frame. This type of construction allows maximum room for easy connection of the motor to the line. A gasket is used between the two halves of the box, which are fastened together with corrosion resistant cap screws.
6. *Sealed Leads* — The leads are brought out through the threaded nipple, which is then filled with a flexible sealing compound.
7. *Cartridge type ball bearings* — The bearings are pre-lubricated with the right amount of the correct grades of grease, and can be relubricated when necessary.
8. *Completely protected laminations*—The stator laminations are isolated from the air stream by the cast iron inner frame which completely surrounds them.
9. *Special varnish treatment*—After the windings are in place, the stator is baked to remove all moisture, and, while still hot, immersed in a heavy insulating varnish. When the heated stator core is immersed in the much cooler varnish a suction is created which produces complete impregnation of the windings. The stator is baked again until this coating is completely dried. It is then given another dipping and baking to insure complete impregnation and to provide an added moisture-resisting coating. Finally, it is treated with a heavy coat of a special acid and alkali resisting varnish which produces a tough oil-proof coating.
10. *Cast aluminum rotor*—The rotor squirrel cage is of aluminum cast under heavy pressure. Each rotor is dynamically balanced to insure freedom from vibration.
11. *Drain plugs*—A drain plug is provided in each endplate so that any condensation inside the motor can be easily removed.
12. *Corrosion resistant nameplate*—Nameplates are of corrosion resistant material, and contain complete operating and service information.
13. *Wide range of sizes*—Both standard totally enclosed fan-cooled and explosion-proof motors are available in ratings from 5 to 250 hp, to meet practically all industrial requirements.

Where corrosion is a problem, the cast iron frame will be little affected

LIQUID COATING FILMS REDUCE CORROSION COSTS

▲ Well accepted authorities now agree that our national corrosion bill is about 5½ billion dollars a year. And because iron and steel constitute the bulk of metal in use, the natural result is that liquid coatings are the major protective measures used in industry's effort to reduce this tremendous economic loss.

Research facilities and product improvements have made great strides in the fight for life that iron and steel have always had to wage. Rust does not battle in the open. It not only destroys secretly, but the destruction it causes is so constant that more than ordinary coatings are required. There must be some element so potent as a rust preventive that the very maximum of protection may be provided.

"Strangely enough," says Robert A. Fergusson, president of the Rust-Oleum Corp., "Nature provided this particular quality in fish oil. For many years raw fish oil had been rubbed on iron and steel surfaces of ocean-going vessels of all kinds, to stop and prevent rust. The sailors knew it worked. The oil did the job, as many an old-time seaman knows. But the odor was bad, and the oil's potency had to be controlled in some way or other. It was my father, Captain Robert Fergusson, with twenty-five years of sea-faring experience, who set himself to the task of overcoming fish oil's offensive smell and giving it the necessary drying quality. The result of his work was first offered to industry in 1922. The rest is history, as many already know."

One of the most serious features of rust's everlasting attacks upon iron and steel is that it does not publicize itself. Fire, another enemy, is spectacular. But rust seldom makes the head-lines. It works quietly, and the

damage it does is so far beyond measurement that the most effective preventive measures possible must be considered as a sensible investment on the part of those who deal with corrosive metals.

CONTROL DRIVE GIVES UNUSUAL FLEXIBILITY

▲ A characterized control drive which can be "tuned" to the requirements of a special application is the latest development of Bailey Meter Co. This completely enclosed air-operated drive makes it possible to parallel characteristics of a driven device with characteristics of other equipment thereby securing a unified system.

The Bailey control drive, consists of a double acting air cylinder (with rigid supporting stand and enclosure) a positioning relay, and a manual operating wheel or lever.

It is the positioning relay which provides the drive's characterizing feature. It incorporates a cam whose shape determines the relation of control drive position to control loading pressure. Three cams are included with each drive and may be used interchangeably to obtain positions which are proportional to the first power (straight line), square, or square root of the control loading pressure. For applications where special relationships are required any one of the three basic cam shapes may be modified easily.

The drive is claimed to be extremely accurate requiring only .10 psi change in control loading pressure to deliver full supply pressure to the piston in the air cylinder. It has unusual flexibility; reaction to increased control pressure may be completely reversed by three simple adjustments, and drive travel and loading pressure range can be changed easily and quickly.

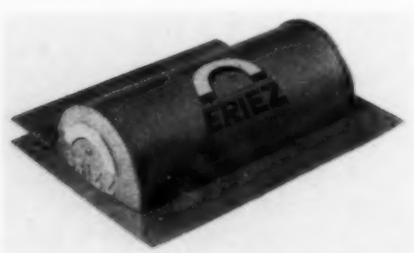
Manual operation is simplified by an air supply shut-off valve, a by-pass valve, a hand lever or wheel, and a clamping device.

PERMANENT MAGNETS SEPARATE TRAMP IRON

▲ Eriez Manufacturing Co. has introduced an entirely new and vastly improved group of non-electric Alnico plate magnets for separation of tramp iron from materials in process. Known as "Atomagnets," they come in three models, each with a different magnetic strength. Each also comes in a full range of sizes. Ten years of experience and research by Eriez, have gone into the design of these plate-magnets.

Five new features of "Atomagnets" are: 1. The magnet castings are now fully encased with a formed cover. This increases longitudinal stiffness; prevents tampering and accumulation of iron on the backs of castings with consequent formation of auxiliary magnetic poles that detract from the efficiency of the normal magnetic field. 2. Parts are riveted rather than bolted together for added structural strength. Warping and bending of large size magnets is eliminated. 3. The hinges on standard models are now made of aluminum, continuous and offset. 4. Insulation of the plate's working surface confines magnetic strength to where it is desired. 5. A flush instead of recessed air gap on the plate face prevents gathering of fine iron.

The features of the new design give improved performance because auxiliary poles are reduced.

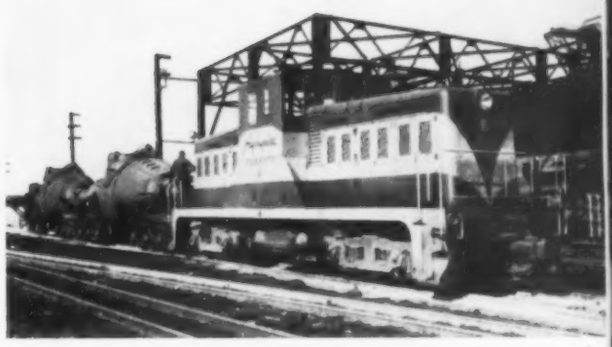


You should be among the
12,000
Industrial Executives and Plant Operating Officials
who will see and learn of
UP-TO-THE-MINUTE Steel
Mill Equipment, Supplies and Services...
at the 1950
IRON & STEEL EXPOSITION
CLEVELAND PUBLIC AUDITORIUM
CLEVELAND, OHIO
Sept. 26, 27, 28, 29, 1950
sponsored by
ASSOCIATION OF IRON & STEEL ENGINEERS
1010 Empire Building, Pittsburgh, Pa.

Whitcomb 25-ton Diesel electric locomotive, narrow gauge, in operation at the Ohio Works (Youngstown) of the Carnegie-Illinois Steel Corporation. One of four Whitcomb Industrial Diesels operating here.

A compact, powerful Whitcomb 50-ton Diesel locomotive delivers inbound cars of scrap and materials to the 100-acre plant of Scullin Steel Company, St. Louis, Missouri.

Whitcomb 70-ton Diesel electric pushing two submarine type cars of molten metal to an open hearth in the Steelton, Pennsylvania, area. Steelton & Highspire Railroad Company.



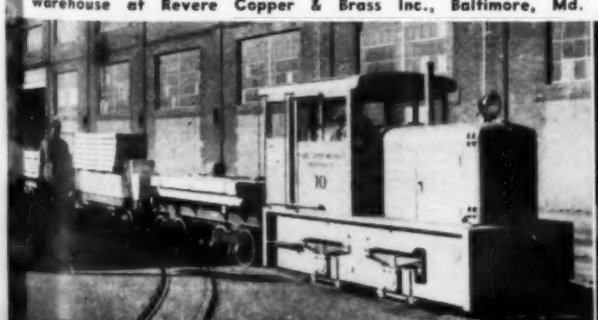
Whitcomb Industrial Diesels: Cost-Saving Production Tools Used Throughout Industry

Wherever materials must be moved in volume, on schedule, and at minimum cost — you'll find Whitcomb Diesel locomotives turning in enviable performance records. Whitcomb Diesel locomotives provide the compact power, the speed, the high availability, the durability needed to meet exacting production schedules. That's why important companies choose Whitcomb Diesels for important jobs.

Whitcomb Industrial Diesels are available in weights from 3 to 95 tons, each tailored precisely to the work to be done. Today, take the first step toward lower production costs by writing for complete information on the Whitcomb Industrial Diesel locomotive line.

Fueling up a Whitcomb 80-ton Diesel electric at a large eastern steel plant. Fuel economy combines with high availability, complete dependability, to assure profitable performance.

In a typical application, where economy counts, a Whitcomb 8-ton Diesel mechanical locomotive delivers materials from plant to warehouse at Revere Copper & Brass Inc., Baltimore, Md.



Whitcomb 20-ton Diesel mechanical locomotive of a type widely used in steel-making operations.

There is no power cheaper than Diesel; no locomotive finer than a Whitcomb.

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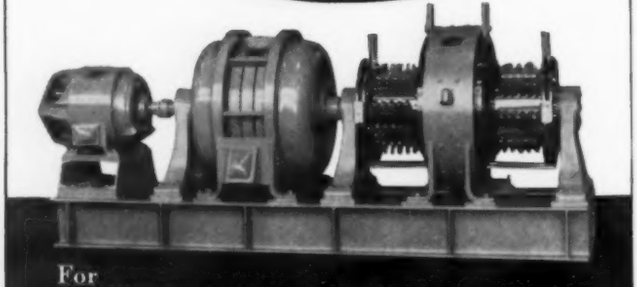

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Book Reviews

▲ A.S.T.M. STANDARDS ON ELECTRICAL INSULATING MATERIALS (With Related Information), a 670-page book, includes all of the standard and tentative test methods and specifications pertaining to electrical insulating materials, which have been issued largely through the work of the American Society for Testing Materials Committee D-9 on Electrical Insulating Materials. The 1950 edition of this book has just been issued. Copies of this publication, heavy paper cover, can be procured from the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., at $4.85 per copy.

▲ A "performance type" building code prepared by the Building Officials Conference of America, Inc., has been published in abridged form for national use by communities which are principally residential in character including the usual civic, commercial and educational buildings essential to community life.

The Abridged building code in its first printed edition is now available from the Building Officials Foundation, 51 East 42nd St., New York 17, at $3.00 per copy, paper covered, and $4.50 per copy, cloth covered. The Basic Building Code will be available in the printed edition about August 1 at $5.00 per copy paper covered, and $6.50 per copy cloth covered.

▲ NEMA STANDARDS FOR SMALL AIR CIRCUIT BREAKERS, Publication No. AB1-1950 contains the conditions for successful operation, the voltage frequency, ampere and interrupting ratings, and tripping voltages for circuit breakers of the trip-free type. The sizes of terminal connectors for front- and rear-connected breakers are given.

Under the section on testing standards will be found the limits of observable temperature rise, the rise for wire-wound and single-layer series coils according to the different classes of insulation, the conductors used, the duration of temperature tests, and a description of the dielectric test. Performance standards are given for interrupting ratings, operating duty, calibration and other factors. ($1.10 per copy) write NEMA, 155 East 44th St., New York 17, N. Y.

▲ The second edition of SALES ENGINEERING by Bernard Lester has recently been issued by John Wiley & Sons, 440 Fourth Avenue, New York 16, N. Y., cloth bound, 221 pages, 5½ x 8½ in., price $3.00. This book is written for technically trained men who sell, design or produce technical products and services. It deals with selling equipment and services that require an engineering skill in selection, application and use. It also gives the type of work involved and opportunities offered in selling machinery, equipment and technical products to the industry.

▲ Metallurgists and scientific workers will be interested in the new book EQUILIBRIUM DATA FOR TIN ALLOYS published by the Tin Research Institute. Concise and accurate, this booklet has been simplified by presenting a single equilibrium diagram for each system. This publication is 7 x 9¾ in., 66 pages with 36 diagrams, and may be obtained from Tin Research Institute, Inc., 492 W. Sixth Avenue, Columbus 1, Ohio, price 50 cents.

▲ A handbook (Transactions Bulletin No. 13, 1949) of helps on air pollution control, including the assessing of smog hazards in narrow valleys, chemistry of smog and behavior of smoke from stacks, is announced by Industrial Hygiene Foundation at Mellon Institute. Dr. George D. Beal, assistant director of Mellon Institute, discusses stream pollution control in the bulletin. Ward F. Davidson, research engineer, Consolidated Edison Co. of New York, reduces to engineering terms for the first time, theories on how stack dust and smoke are dispersed in relation to stack and building heights, gas velocity, temperature and other factors influencing air pollution. In discussing the ventilation of valleys, Prof. H. C. Willett of Massachusetts Institute of Technology disclosed that "once a smog is established, it tends to assist its own perpetuation." This publication is available to non-members of Industrial Hygiene Foundation at $2.00 per copy, 4400 Fifth Ave., Pittsburgh 13, Pa.

INDEX TO ADVERTISERS

A

Aetna-Standard Engineering Co., The 1
Alliance Machine Co., The 150
Askania Regulator Co. 161

B

Bantam Bearings Division, The Torrington Co. 128
Bedford Foundry and Machine Co. 157
Birdsboro Steel Foundry and Machine Co. 162
Bloom Engineering Co. 157
Bonnot Co., The 154
Brandt, Inc., Charles T. 163
Brosius Co., Edgar E. 148
Browning and Co., Inc., Victor R. 142
Buffalo Forge Co. 129

C

Cities Service Co. 143
Clark Controller Co. 6
Cleveland Crane and Engineering Co. 28
Cleveland Worm and Gear Co., The ..... Cover 3
Columbia Electric Manufacturing Co. 174
Continental Foundry and Machine Co. 130, 131
Crane Co. 164
Crouse-Hinds Co. 26, 27
Cunningham Co., M. E. 174
Cutler-Hammer, Inc. ..... Cover 2

D

De Laval Separator Co. 13
De Laval Steam Turbine Co. 165
Documentation & Licenses, Paris, France 32
Dowell, Inc. 132
Dravo Corp. 159
Drever Co., The 32

E

Electric Controller and Manufacturing Co. 5, 139
Electric Service Manufacturing Co. 166
Electric Storage Battery Co., The 15

F

Falcon Bronze Co. 160
Farrel-Birmingham Co., Inc. 158
Fawick Airflex Co. 145
Flinn & Dreffein Engineering Co. 32
Furnace Engineers, Inc. 156

G

General Electric Co. ..... Cover 4, 8, 9

H

Hagan Corp. 167
Hallden Machine Co., The 32
Harnischfeger Corp. 21
Heyl and Patterson, Inc. 22, 23
Homestead Valve Manufacturing Co., Inc. 119
Hyde Park Foundry and Machine Co. 160

I

Iron and Steel Exposition 4

J

Johns-Manville Corp. 151
Jones Foundry and Machine Co., W. A. 147

K

Koppers Co., Inc. 140, 141

L

Leeds and Northrup Co. 12
Lewis Foundry and Machine Division, Blaw-Knox Co. 11
Linde Air Products Co., The, Unit of Union Carbide and Carbon Corp. 168
Link-Belt Co. 127

M

Manning, Maxwell and Moore, Inc., Shaw-Box Crane and Hoist Division 31
Mathews Conveyer Co. 138
Medart Co., The 144
Mesta Machine Co. ..... Cover 1
John Miles & Partner (London, Ltd.) 32
Minneapolis-Honeywell Regulator Co., Industrial Division 146
Morgan Construction Co. 20
Morgan Engineering Co. 170
Murray Manufacturing Co., D. J. 155

N

National Bearing Division, American Brake Shoe Co. 14
National Carbon Division, Union Carbide and Carbon Corp. 152
National Roll and Foundry Co. 2

O

Oakite Products, Inc. 160
Ohio Electric Manufacturing Co., The 136
Okonite Co., The 10

P

Pennsylvania Transformer Co. 7
Pittsburgh Lectromelt Furnace Corp. 34
Poole Foundry and Machine Co. 178
Post-Glover Electric Co. 125

R

Reliance Electric and Engineering Co. 19
Rust Furnace Co. 117
Rust-Oleum Corp. 16

S

Smeeth-Harwood Co. 142
Square D Co. 135
Surface Combustion Corp. 120, 121

T

Taylor Sons Co., Chas. 169
Texas Co., The 3
Timken Roller Bearing Co., The 25

U

Union Carbide and Carbon Corp., The Linde Air Products Co., Unit 168
Union Carbide and Carbon Corp., National Carbon Division 152
United Engineering and Foundry Co. 17

W

Wagner Electric Corp. 30
Ware Fuse Corp. 159
Wean Engineering Co., Inc., The 32
Wean Engineering Co. of Canada, Limited, The 32
Wean Equipment Corp. 32
Whitcomb Locomotive Co., The 173
Wilson Engineering Co., Inc., Lee 24

Y

Youngstown Alloy Casting Corp. 18
Youngstown Foundry and Machine Co., The 123

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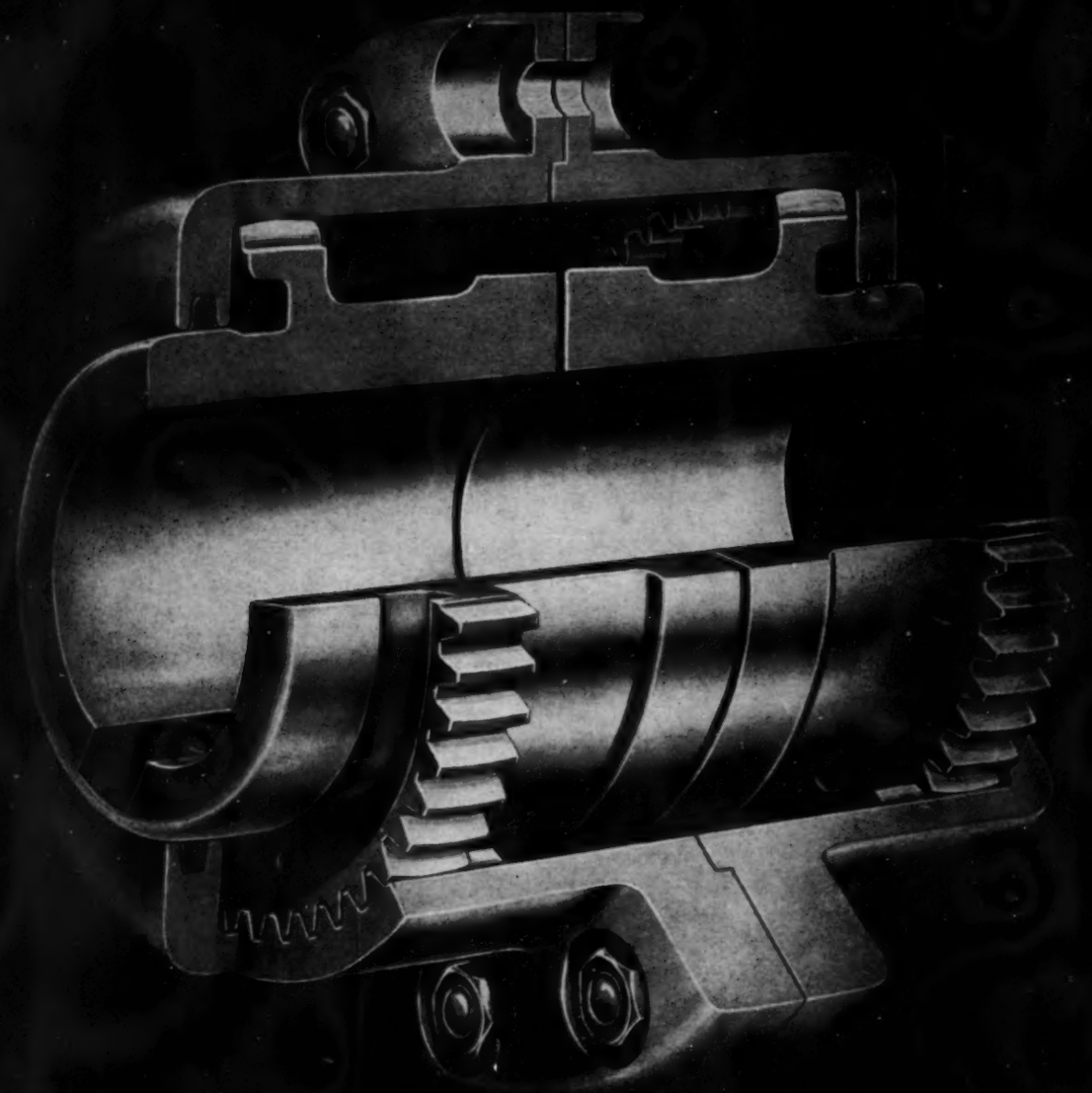

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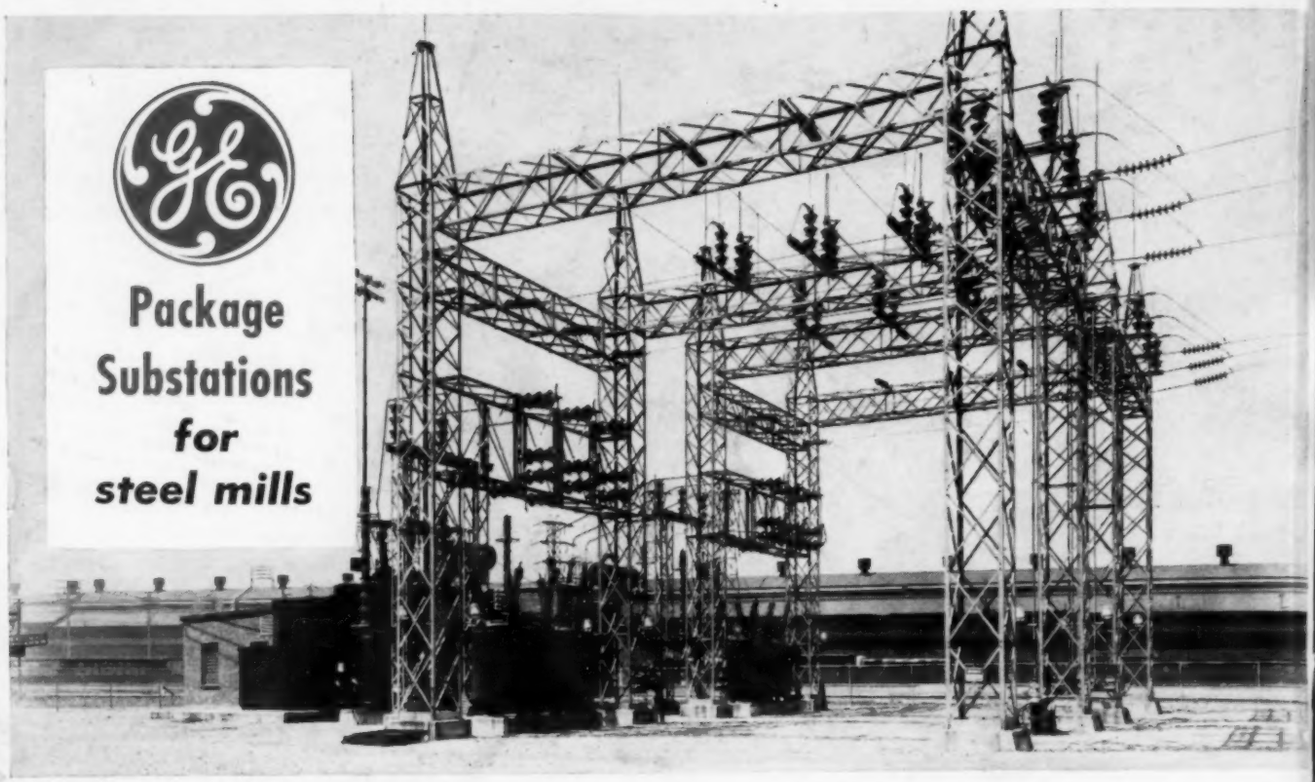

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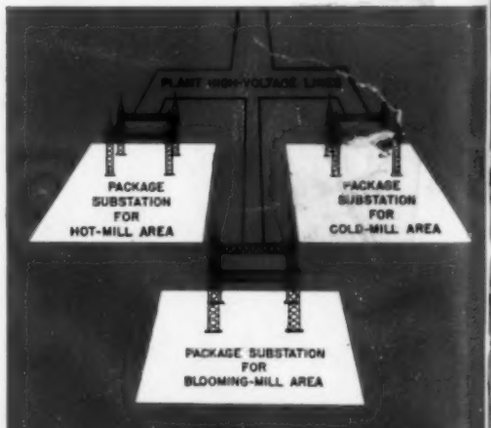
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